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Power for Ft. Dearborn National Bank Building

HIGH-PRESSURE STEAM PURCHASED FROM ADJOINING BUILDING FOR RUNNING GENERATORS AND PUMPS

CONFRONTING THE ENGINEERS of nearly all isolated power plants of moderate to small size, is the question, will it pay to buy power or generate it? Sound arguments are presented on both sides of the question, but a new phase of the problem has presented itself in the case of the Ft. Dearborn National Bank Bldg., in Chicago. For the past 10 yr. this building has been purchasing high-pressure steam for the operation of house and elevator pumps, also low-pressure exhaust steam for the heating system, and electric power from an adjoining building. The steam was purchased on a flat rate per year, but the electric power was metered and paid for accordingly.

On the 30th of April the purchase of electricity and exhaust steam will be discontinued, but high-pressure live steam will still be bought, not, however, on a flat rate, but according to meter readings. The plant will run its pumps and generate its own electric power on

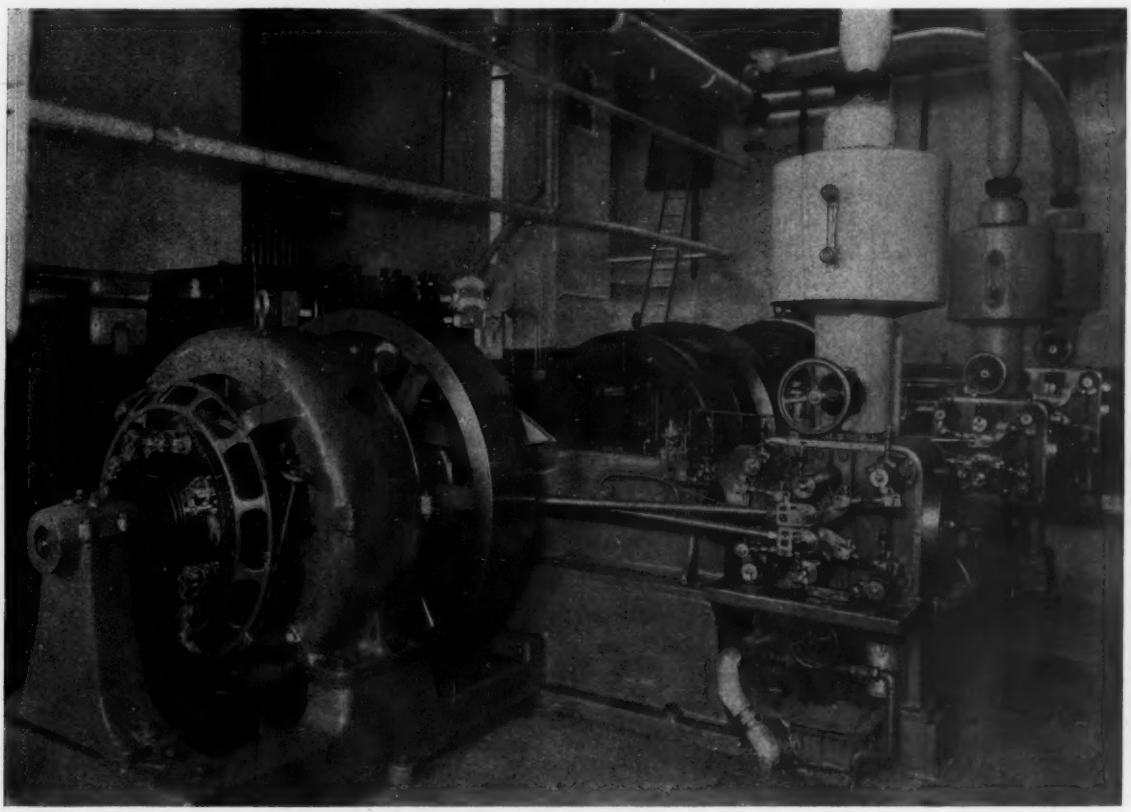


FIG. 1. RECENTLY INSTALLED GENERATING UNITS

purchased steam and the heating of the building will be done with the exhaust steam from the pumps and engines. By this arrangement the engineer, Frank Erlenborn, has estimated that considerable saving can be made over the previous arrangement or any arrangement offered by central station representatives.

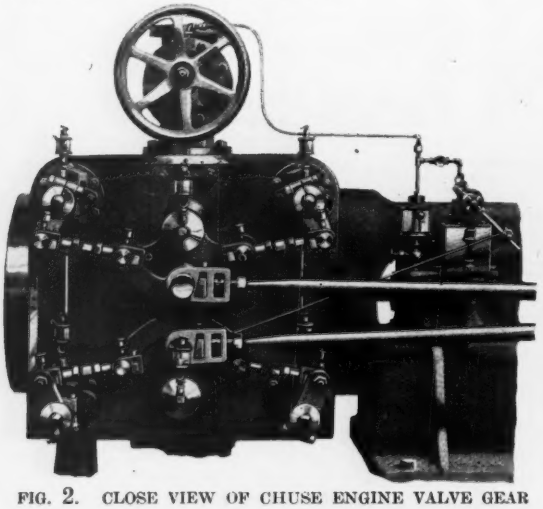


FIG. 2. CLOSE VIEW OF CHUSE ENGINE VALVE GEAR

To make the change it was necessary to install 3 generators and switchboard equipment for controlling the electric power.

The New Units

Generating equipment consists of 3 Chuse non-releasing Corliss engines direct connected to Crocker-Wheeler direct-current generators. Engine No. 1 is 14 by 19 in., and runs at 200 r.p.m., driving a 125-kw. generator; No. 2 is 12 by 16 in., speed 200 r.p.m., driving a 75-kw. generator; No. 3 is 11 by 14 in., speed 225 r.p.m., driving a 50-kw. generator. The voltage carried in the plant is 115.

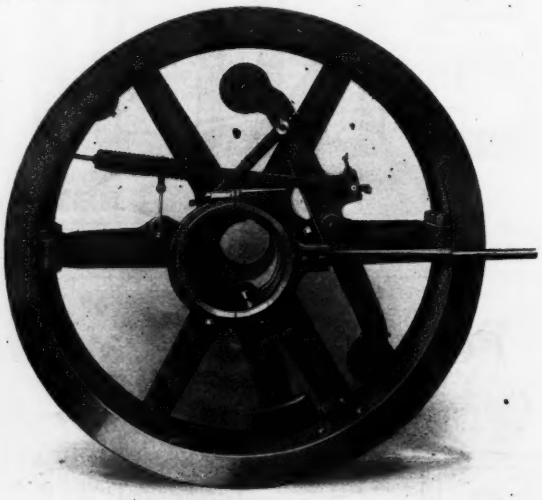


FIG. 3. GRAVITY BALANCED INERTIA GOVERNOR USED ON CHUSE ENGINES

Some of the distinctive features of the engines are worthy of note, as they have resulted in higher economy of steam and closer speed regulation. By making the wrist plates extra heavy, rocker arms have been dispensed with, thus driving the wrist plates direct from the eccentrics. To take up wear and eliminate noise in the

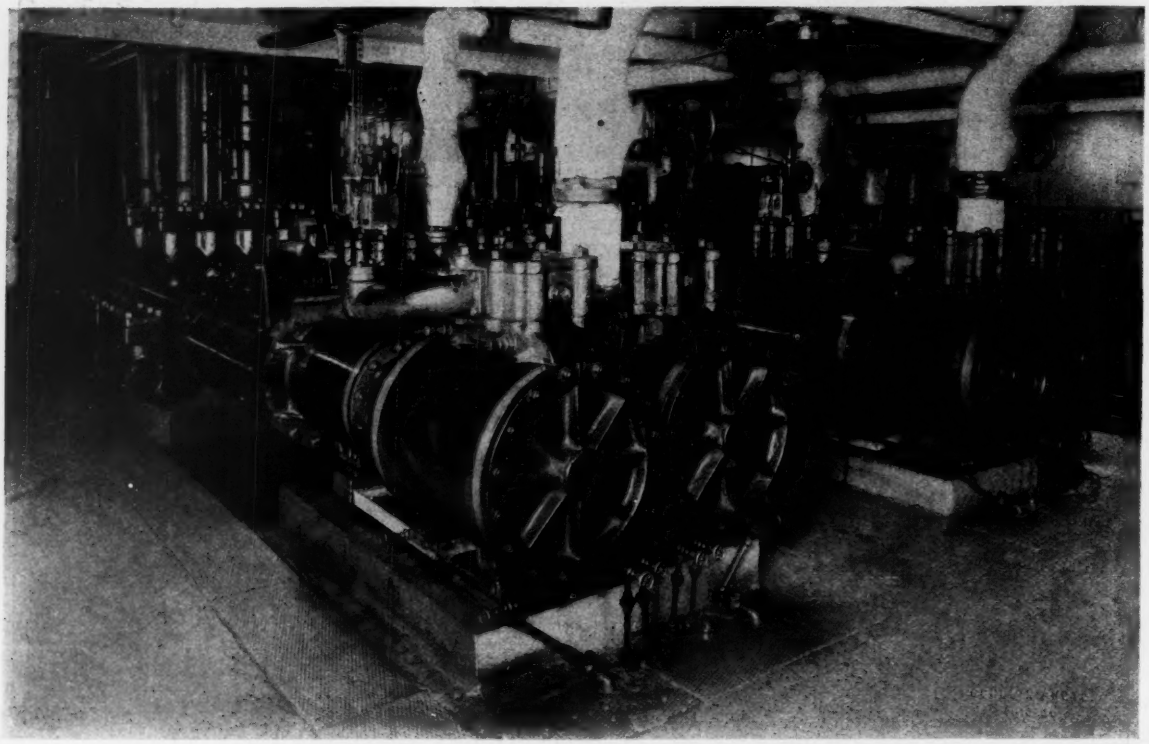


FIG. 4. COMPOUND DUPLEX ELEVATOR PUMPS

valve gear, large pins are used and each of the brasses is provided with a wedge adjustment similar to that used on connecting rods.

Each valve rod is made up of 2 brass heads connected by an adjusting screw with right and left threads so that valve adjustment may be made quickly. The toggle motion of the gear gives the valves a distinct pause during the period of greatest unbalanced pressure and starts up its movement at a slow rate, but moves rapidly at the time the valves are opening and closing, giving a close approximation to the releasing Corliss valve motion. The same mechanism is used on the exhaust valves as on the steam valves, giving them quick opening and closing and a pause at greatest unbalanced period.

Governing, by which a regulation of 1 per cent is secured, is done with a gravity balanced inertia type governor. Being gravity balanced, it is stable at any speed without the use of dash pots.

Elevator Equipment

In the building are 7 Otis hydraulic elevators of the 6 to 1 inverted ram type. Pressure for operating these is maintained at 850 lb. by 3 Laidlaw-Dunn-Gordon elevator pumps. Two of these are compound duplex pot valve, outside packed plunger type, 14 and 20 by 5¼ by 18 in. The main pump is of the flywheel type, having 2 flywheels, one high and 2 low-pressure steam cylinders and 3 single-acting water cylinders; the valve gear is of the Corliss type and the dimensions of the pump are 17-20 and 20 by 24 by 5.

The pilot auxiliary pump is a compound duplex, 8 and 12 by 7 by 10, which delivers the water to the suction of the elevator pumps. In addition a simple duplex pump 12 by 7 by 10 ordinarily used for house service, may be used as a pilot auxiliary.

Vacuum is maintained in the heating system by 2 Marsh simplex pumps each 8 by 12 by 12.

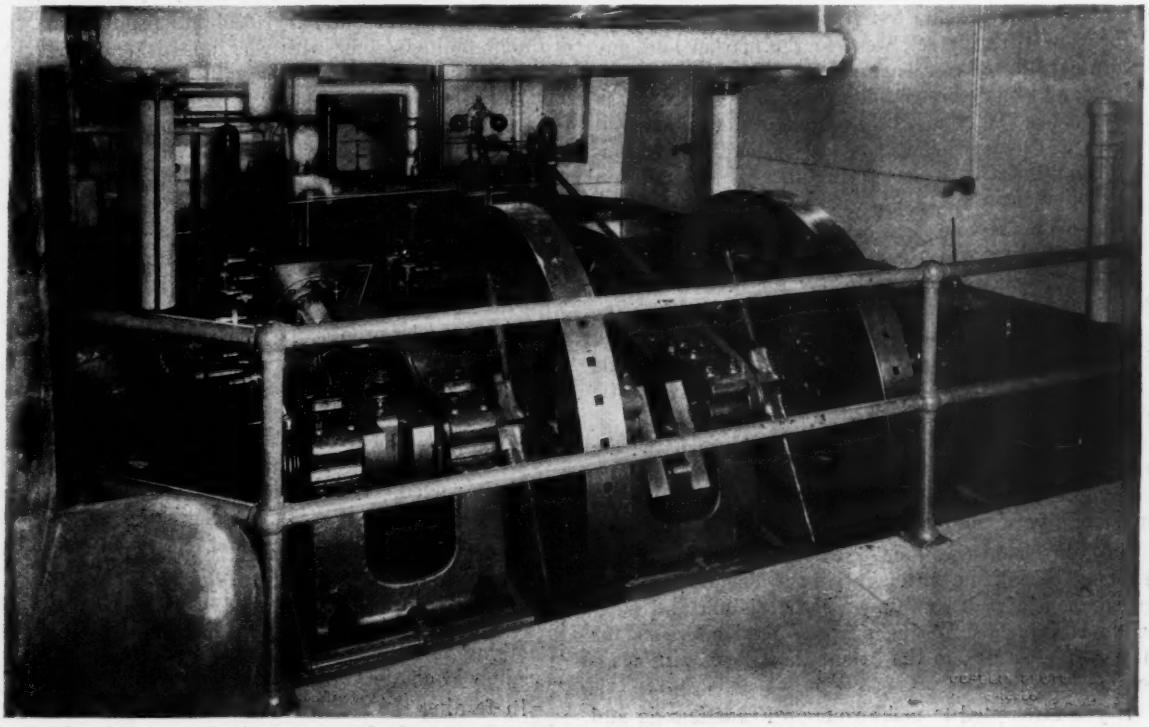


FIG. 5. FLYWHEEL TYPE ELEVATOR PUMP

The switchboard is made up of 4 panels, one for each generator and one service panel with 2 voltmeters mounted on brackets at the end of the board.

Besides furnishing electric current for lights in the building, the generators furnish current to drive the ventilating fans, consisting of a 40-hp. motor driving an exhaust fan; one 9 and one 11-hp. motors drive fans supplying air through indirect heating systems for the bank vaults. Besides these, current is used by a Yeomans Combined Duplex Electric Ejector and Pit located in the engine room, a Palm vacuum cleaning system and a Goulds triplex motor-driven house service pump requiring 40 hp.

The Johnson system of heat regulation is employed, for which 2 small steam-driven air compressors are used and a high-pressure Westinghouse air compressor is used for supplying air to the elevator system.

From the above it will be noted that a great share of the equipment using high-pressure steam is pumps, which do not use steam expansively, and while under the former arrangement for purchasing exhaust steam for heating no credit was given the plant for the exhaust from its own pumps, it was estimated that over half the necessary exhaust steam for heating came from these pumps.

High-pressure steam was also purchased on the flat rate, but for making an estimate of the amount of steam

which would be required all pumps are equipped with stroke counters.

Steam is delivered through a 6-in. header of extra heavy steel pipe with welded flanges. The length of the header is 120 ft., but the distance of transmission from the boiler plant is merely through the building wall. The pressure carried is 150 lb., and a Republic steam flow meter of the indicating, integrating and recording type is used to measure the amount used. It is expected, from estimates of steam consumption of the generating units, and the electrical load, that sufficient exhaust steam will be available for heating the building comfortably at all times except possibly during extremely cold weather.

Records of the plant show the daily consumption of steam, the amount of power used and the water pumped for different purposes. At present a comparison of actual operating costs of the former and present equipment cannot be made, but the results will be watched with interest.

Boiler Feed Water--IX*

VALUE OF A CHEMICAL SET; MAKING YOUR OWN COMPOUND; CURE FOR INCRUSTING SOLIDS. BY F. F. VATER

A SUFFICIENTLY accurate chemical set can be bought including full instructions for operating it, all contained in a neat wall cabinet for $25 or $30. You may be paying $40 a barrel for compound and getting some benefit; but if you stopped that, paid $30 for your titrating set, went in the market and put $10 into caustic soda or barium hydrate, you will keep the boilers in such better shape and on the purchase of 2 barrels or $80, you will have your chemical set, $30 in cash and enough chemical to last as long as the compound would, without considering the better condition of the boiler.

You can make your own caustic soda, if you prefer, at a cost of about $1.50 per hundred, instead of $2 or $2.25, which you would have to pay for it. To do this, take a tank that will hold 1000 lb. of water. Put into the tank 1000 lb. of hot water. Then put in 100 lb. of soda ash, then 70 lb. of lime; stir thoroughly and let it settle and you will have a clear 10 per cent solution of caustic soda.

Siphon the solution into another tank, keep the air away from it, and use the sediment in the mixing tank to fertilize your kitchen garden or upon the grass in your front yard, and watch things grow.

Now, in chemistry, lime is calcium. Commercially, lime may be calcium or magnesium. The lime that is burned from a rock containing both calcium and magnesium is valueless for the purpose cited above or for water softening use, to the extent that it contains magnesium.

If you attempted to make your own caustic soda and used 70 lb. of a lime which contained 40 per cent magnesia, you would have to use 116 lb. of it instead of 70 lb.

You cannot tell without an analysis whether it is burned from a calcite rock or from a rock composed of calcium and magnesium. Your only safety, therefore, is to buy a water softening lime, burned from calcium, and it should be guaranteed by the makers to be burned from a 95 per cent calcium rock and to be at least 90 per cent pure lime. With such a lime, you can use it in lump form, in which it contains silica and alumina and probably some iron, while in the hydrate form, it will be more nearly pure, and it is much easier to handle. Under any circumstances, it should be freshly burned, as upon standing, it absorbs carbonic acid from the air, becoming calcium carbonate and therefore useless, as it will not absorb any more carbonic acid.

I have seen some owners of water softening plants run out of real lime and try to obtain results from the ordinary builders' lime with very unsatisfactory results. I want to impress you with the value of barium hydrate. You may be paying from 8 to 12 cents a pound for boiler compound, the base or active matter in it being either soda ash or caustic soda. Why do this when you can buy barium hydrate at 4 cents a pound and pay nothing for the substances used to hide the fact that you are really getting only caustic soda or soda ash.

The reaction of barium hydrate on the lime and magnesia salts is two-fold just as it is with caustic soda with the added value that it leaves nothing in the water, as an end or by-product, as does soda.

If you have some foaming in using compounds and change to the use of barium hydrate, you will find this tendency reduced, and if you use it in connection with a chemical set, it will stop the tendency. A small quantity of barium hydrate is made in this country, but it is largely imported. The imported product comes in drums in what looks like a cooled-off molten mass. This is difficult to handle and it is preferable to buy it in the precipitated form.

Keep it airtight, as it deteriorates rapidly when exposed to the air, just as caustic soda or lime do. There is nothing you attempt to do in this life, but that doing it right will obtain you satisfactory results.

In feeding the reagents named herein, to feed them right means to feed enough and not too much. In order to feed just enough you must know what your water is, and this can only be obtained by having an analysis made of it.

After having your water analyzed, we will say it contains 7 grains of sulphate per gallon. Therefore, 1000 gal. would contain 7000 grains of sulphate. In using soda ash, caustic soda, or barium hydrate, the right way to use it, is to use just enough to change the form of the sulphate. As approximately 1 grain of sulphate requires 1 grain of soda for the chemical reaction; to handle properly 1000 gal. of water containing 7000 grains of sulphate, you would feed 7000 grains of soda ash or caustic soda. As there are 7000 grains to a pound, you would have to feed 1 lb. of soda per 1000 gal. of water. Barium being heavier than soda, for each

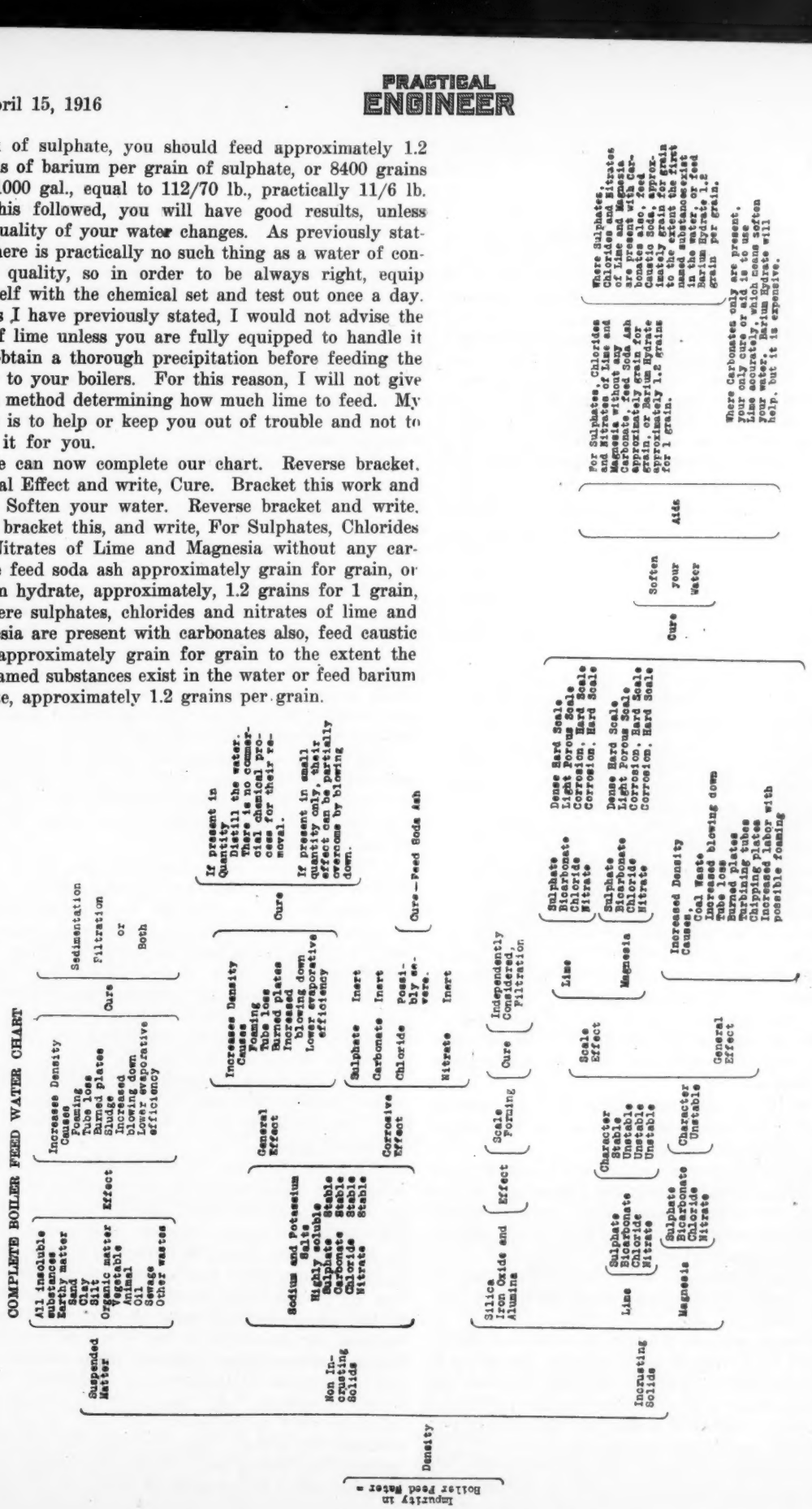
*Concluding chapter of the series.

grain of sulphate, you should feed approximately 1.2 grains of barium per grain of sulphate, or 8400 grains per 1000 gal., equal to 112/70 lb., practically 11/6 lb.

This followed, you will have good results, unless the quality of your water changes. As previously stated, there is practically no such thing as a water of constant quality, so in order to be always right, equip yourself with the chemical set and test out once a day.

As I have previously stated, I would not advise the use of lime unless you are fully equipped to handle it and obtain a thorough precipitation before feeding the water to your boilers. For this reason, I will not give you a method determining how much lime to feed. My desire is to help or keep you out of trouble and not to make it for you.

We can now complete our chart. Reverse bracket. General Effect and write, Cure. Bracket this work and write, Soften your water. Reverse bracket and write. Aids; bracket this, and write, For Sulphates, Chlorides and Nitrates of Lime and Magnesia without any carbonate feed soda ash approximately grain for grain, or barium hydrate, approximately, 1.2 grains for 1 grain, or where sulphates, chlorides and nitrates of lime and magnesia are present with carbonates also, feed caustic soda, approximately grain for grain to the extent the first named substances exist in the water or feed barium hydrate, approximately 1.2 grains per grain.



Then write where carbonates only are present, your only cure or aid is to use lime accurately, which means soften your water. Barium hydrate will help, but it is expensive. The chart is now complete.

To make the subject clearer, I will cite a concrete example. Suppose your water shows by analysis, 3 grains of sulphate, 2 grains of chlorides, 1 grain of nitrates of lime and magnesia, you would approximately feed 6 grains of soda ash.

If the water also contained 12 grains of carbonates, you would need to feed approximately 6 grains of caustic soda. In either case, if you used barium hydrate, you would feed in the ratio of approximately 1.2 to 1, instead of 1 to 1. In following the suggestions I have given you, be careful; be accurate. You cannot guess at anything. Know you are right. Care killed a cat, but it never did any damage in a boiler room.

The effect of heat in chemical reactions is remarkable. If you are going to make a solution of soda ash and try it with cold water, you will have trouble. Cold water applied to soda ash will not dissolve it; on the contrary, it will make it cake so hard you will have to chip it with a cold chisel. On the contrary, if you make your solution of hot water it will dissolve almost instantly.

The solubility of all the chemicals I have referred to varies with the temperature. Soda ash dissolved in just enough water at 100 deg. F. (37.77 deg. C.) to form a saturated solution, remains saturated only if this temperature is maintained at 100 deg. F. (37.77 deg. C.), or is increased. Beyond a certain point an increase of temperature brings a decrease in solubility.

This is more or less true of all chemicals and to avoid trouble make your solutions dilute.

If you are preparing a solution of soda ash, caustic soda or barium hydrate, you will avoid stopping up of your solution piping by using a dilute solution. A dilute solution is one in which the maximum solubility of the substance being dissolved is but approximately reached. The most convenient dilution to use around a boiler room is a 10 per cent solution, because with solutions of this strength you are beyond the reach of trouble due to temperature changes. A 10 per cent solution is easy to prepare and easy to change, if a change be needed.

Using 50 lb. of chemical, either soda ash, caustic soda or barium hydrate, you would use 500 lb. of water to obtain a solution of 10 per cent.

There is another distinct advantage in using dilute solutions. If you are handling the proposition with a titrating set, so that you know what you are accomplishing, a dilute solution will have to be fed in greater quantity than a saturated solution.

This results in getting a better diffusion of chemical through the water which means obtaining a more comprehensive result.

For instance, suppose your water was of a nature that required 1 c.c. of a saturated solution per gallon of water to bring about thorough chemical reaction; by using a dilute solution, 30 c.c. of the solution would have to be fed, and it stands to reason that 30 c.c. will permeate 1 gal. of water more readily than 1 c.c.

C.c. means cubic centimeter. A cubic centimeter is a thousandth part of a liter. It is 0.061 of a cubic inch. There are 16.837 c.c. in a cubic inch, and as there are 231 cu. in. in a gallon, there are 3785.397 c.c. in a gallon.

In making a 10 per cent solution, it is not necessary to be exact. You don't have to weigh the water or the chemical to an ounce. Get it approximately 10 per cent. Weighing will be a benefit in one way, viz., if you always weigh the chemical and the water, your solution will always be of uniform strength, and you will not have to vary the proportion you feed when you make a new solution.

Heat promotes the rapidity and thoroughness of almost any chemical reaction. In other words, the element of time required to obtain a chemical reaction varies with the degrees temperature under which the reaction takes place.

It will take more time to change the sulphate of lime to sodium sulphate and lime carbonate in a water of 40 deg. F. (4.44 deg. C.) temperature, than it would under a temperature of 100 deg. F. (37.77 deg. C.). Still less time would be required if the temperature were 180 or 200 deg. F. (82.22 or 93.33 deg. C.).

If chemical reactions and sedimentation were instantaneous it would be an easy matter to keep your boilers clean without installing a softening device. Sedimentation or the settling out of a precipitate from a water takes time. The time required for this operation depends upon the precipitate you have to remove. In some waters 24 hr. time will not render them clear. Other waters will clear in an hour.

Time being so necessary for both chemical reactions and sedimentation, you should get the solutions into the water at the earliest point practicable, as in this way you get a more thorough result before the water reaches the boiler.

Throw out that little cheese box you call a heater. Measure it up and find its holding capacity. If you are using 250 hp., or 1000 gal. of water an hour, you require 16/23 gal. a min., and if a time element of 3 min. is allowed, the carrying capacity of the heater would be 50 gal. Now, if an hour's time is required for chemical reaction and sedimentation, what will you get in 3 min.? Practically nothing. Get a new heater that will hold some water, which will give you a time element of some value to you.

This is the reason so many so-called feed water heaters and purifiers are such failures. The water doesn't stay long enough in the heater for the chemical to get acquainted with it.

We know the effect of heat on chemical reactions up to moderate temperatures, but we don't know what they are at the temperature of steam at 165 lb. pressure. Effects are sometimes found in boilers that can only be accounted for upon the basis that there takes place at high temperatures a disassociation of the elements in a water, such as the release of hydrogen, for instance. At the University of Illinois, where serious pitting and corrosion has occurred, it has been practically proven that such disassociation does take place, and that hydrogen is the cause of the trouble. Under high temperatures, changes in form may take place, rendering a substance very active instead of inert, in which form it enters the boiler. Therefore, all the greater is the necessity of feeding boilers with water, with just plain H_2O, instead of H_2O plus many titles.

Investigation of the Pressure Drop in Steam Pipes*

By M. Guilleaume

THE following kinds of gate valve were tested: 1. The "Ferranti" gate valve, with quarter area passage, for 8, 11 and 12-in. pipe, Fig. 7. 2. Hopkinson parallel gate valve with full passage (Fig. 8), for 8-in. and 12-in. pipe. 3. Hopkinson, with ¾ passage, for 8 and 12-in. pipe (Fig. 9). 4. "Konig" shut-off valve (Fig. 10), for 8-in. pipe, with 2-in. hub. 5. Konig, for 8-in. pipe with 2⅝-in. hub. The results of the tests of 8-in. valves are summarized as follows:

Valve No.	R. average.	Per cent of R for 8-in. globe valve.	R for 8-in. globe valve.
1	18.30	58	
2	1.29	4	31.22×10^{-6}
3	3.82 $\times 10^{-6}$	14	
4	21.92	69	
5	17.37	55	

Figure 11 is a diagram showing in graph form the relative resistance of the different kinds of valves under varying conditions.

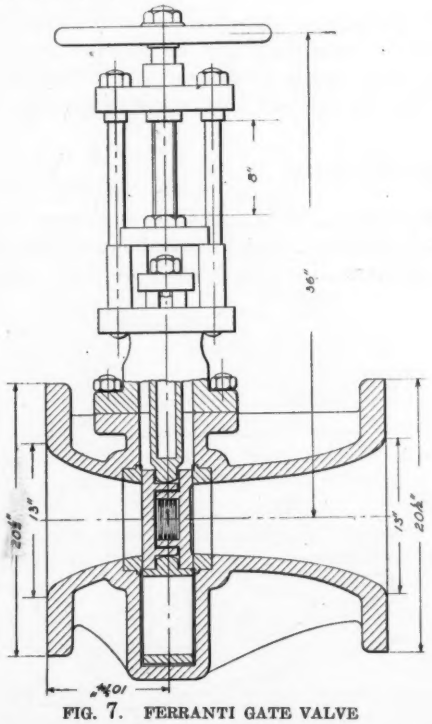


FIG. 7. FERRANTI GATE VALVE

In these tests steam velocity averaged about 160 ft. a sec., and pressure about 180 lb. absolute. Superheated steam at about 608 deg. F was used. The Ferranti valve was tested in 3 sizes, and the average value of R was found to be 18.30×10^{-6} for 8-in.; 22.19×10^{-6} for 11-in., and 25.18×10^{-6} for 12-in. Twelve-inch Hopkinson valves were also tested, the results being, for full passage $R = 0.74 \times 10^{-6}$, and for ¾ passage, $R = 2.51 \times 10^{-6}$.

Pressure Drop in Spherical Tees

Loss of pressure in a globe valve is due to the whirling and friction caused by the Z-form change of direction. It is therefore of interest to discover what is the loss caused by an L-form change of direction, as in a tee or ell. The section of 12-in. pipe used in the tests is shown in Fig. 12. The average steam pressure was about 195 lb. abs., velocity 80 ft. a sec., and temperature, 644 deg. F. The average value of R for 7 tests was found to be 41.1×10^{-6}, which is greater than for any of the valves tested.

Pressure Drop in Pipe Combinations

1. From boiler to steam header. A Babcock & Wilcox boiler with 3278 sq. ft. heating surface and superheater was used. (Fig. 13.) An 8-hr. test gave the following results:

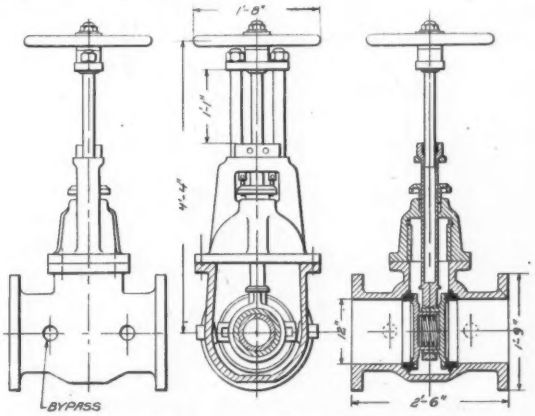


FIG. 8. HOPKINSON GATE VALVE WITH FULL PASSAGE

Av. steam pressure, 203 lb. per sq. in. abs.
Av. temperature, 698 deg. F.
Av. steam density, 0.297.
Av. weight of steam per hour, 13,431 lb.
Av. velocity of steam in 7-in. pipe to header, 48.4 ft. a sec.
Av. evaporation per sq. ft. H. S. per hr., 4 lb.

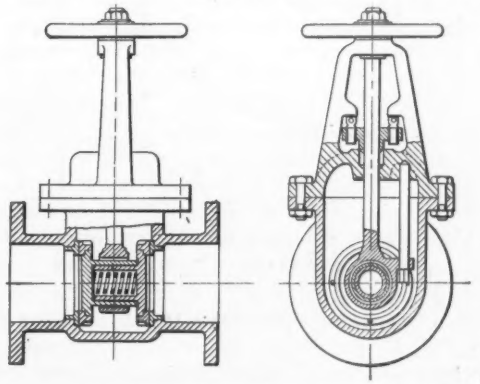


FIG. 9. HOPKINSON GATE VALVE WITH ¾ PASSAGE

An average pressure drop of 5.9 lb. per sq. in. was observed between boiler and header. Further tests at different pressures with the same boiler gave the following results:

*Continued from p. 288, Mar. 15 issue.

Evap. per sq. ft. H. S. per hr.	Pressure drop lb. per sq. in.	Steam velocity ft. a sec.
3	3.3	36
3.5	4.5	42
4.5	7.4	54

A Borsig boiler with 4445 ft. H. S. and superheater, Fig. 14, gave the following results:

Average steam pressure, 222 lb.
Average steam temperature, 694 deg. F.
Average steam density, 0.326.
Average steam velocity in 8-in. pipe, 71 ft. a sec.
Average evap. per sq. ft. H. S. per hr., 6.29 lb.
Total weight of steam per hour, 28,564 lb.

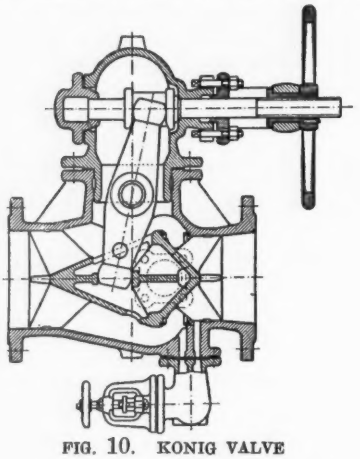


FIG. 10. KONIG VALVE

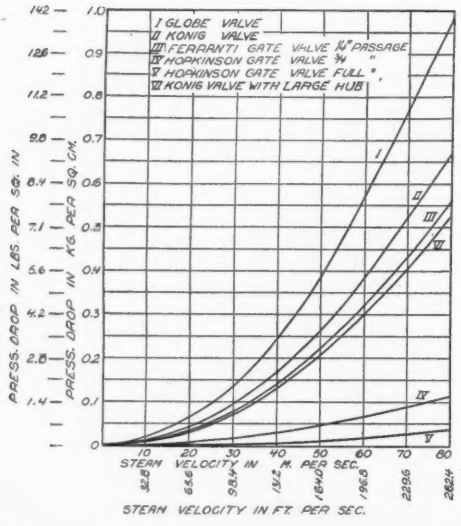

I GLOBE VALVE
II KONIG VALVE
III FERRANTI GATE VALVE ½" PASSAGE
IV HOPKINSON GATE VALVE ¾ "
V HOPKINSON GATE VALVE FULL "
VI KONIG VALVE WITH LARGE HUB
PRESS. DROP IN LBS. PER SQ. IN
PRESS. DROP IN KG. PER SQ. CM.
STEAM VELOCITY IN M. PER SEC.
STEAM VELOCITY IN FT. PER SEC.

FIG. 11. CURVES SHOWING RESISTANCE OF TESTED 8-IN. VALVES AT VARYING STEAM VELOCITIES

The pressure drop observed was 6.5 lb. per sq. in Other tests gave:

Evap. per sq. ft. H. S. per hr.	Pressure drop lb. per sq in.	Steam velocity ft. a sec.
5	4.1	56.8
5.5	5	62
6	5.9	68.2
6.5	7	74
7	8	79.6

PRESSURE DROP THROUGH STEAM SEPARATOR AND VALVE IN TURBINE

THREE TESTS were made. 1. A 3000-kw. Allgemeine Elektrizitats Gesellschaft turbine, having a cast-iron steam separator with concentric baffles, tangential inlet and radial outlet steam pipes, with steam density 0.279, gave a pressure drop of 8.4 lb. per sq. in. 2. Same turbine and steam separator with steam density 0.3 gave pressure drop 5.83 lb. per sq. in. 3. A 6000-kw. A. E. G. turbine, with wrought-iron steam separator, having radial inlet and outlet steam pipes; steam density 0.288, pressure drop 6.7 lb. per sq. in. As a general rule it may be said that with turbine at full load, the pressure drop in this pipe combination is about 7 lb. per sq. in.

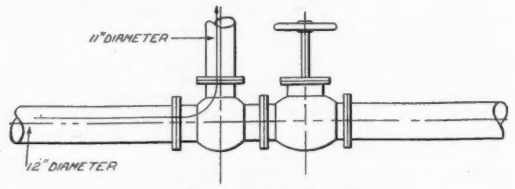


FIG. 12. SPHERICAL TEE

The foregoing tests were made in order to give a safe basis of calculation for the pressure drop in steam piping. The results may be summarized as follows:

1. Eberle's formula for the loss of pressure in steam pipes—

$$P_1 - P_2 = 14.22\left[R_F \times \frac{d}{0.062} \times \left(\frac{V}{3.28}\right)^2 \times \frac{L}{D}\right]$$

gives for pipes of large diameter values near enough for practical purposes, and makes allowance for bends of large radius and uneven heating of pipes and flanges.

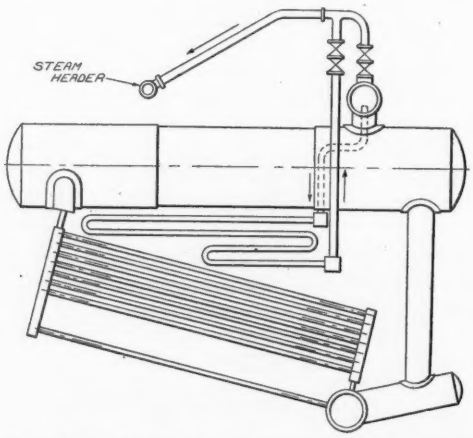


FIG. 13. BABCOCK & WILCOX BOILER TESTED

2. The commonly accepted length of 55 ft. of pipe as resistance equivalent for an ordinary globe valve of the same diameter, is true only in the case of 2¾-in. pipe, and for pipes of large diameter gives entirely too small values.

3. The pressure drop in valves is given by the equation—

$$P_1 - P_2 = 14.22\left[R_V \times \frac{d}{0.062} \times \left(\frac{V}{3.28}\right)^2\right]$$

(The diameter of the valve is taken care of by the value R.)

The tendency in modern power plants to use steam at high velocities practically excludes the use of globe valves, on account of their high resistance, as shown by Fig. 11; whereas certain forms of gate valve are especially suitable for this purpose.

4. The right-angled turn of direction in the flow of steam in a tee produces a resistance greater even than that of a globe valve, and for this reason such abrupt changes of direction must be avoided.

The formula commonly used in this country is

$$W = K\sqrt{\frac{fgd^5}{L\left(1+\frac{3.6}{d}\right)}}$$

in which W = weight of steam flowing in pounds per minute; f = pressure drop in pounds per square inch; g = density of steam; d = diameter of pipe in inches; L = length of pipe in feet, and K a coefficient, varying according to different authorities from 87 to 87.5. Taking the value 87, this formula gives for 328 ft. of

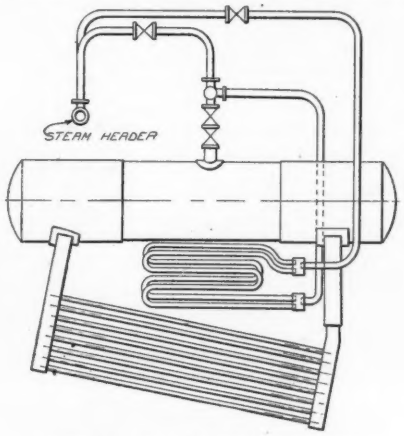


FIG. 14. BORSIG BOILER TESTED

12-in. pipe, with a steam velocity 165 ft. a sec., and density 0.31, a pressure drop of 4.38 lb. per sq. in., whereas Eberle's formula gives 6.23 lb. For pressure drop in globe valves, the following formula is used here to find the equivalent length of pipe of the same diameter:

$$L = \frac{114d}{\left(1+\frac{3.6}{d}\right)}$$

in which L is in feet and d in inches. For a 12-in. valve, this formula gives 1053 ft. in place of the 334 ft. as given by the B. E. W. tests.

The table on page 286, Mar. 15 issue, gives a summary of the results of the investigation. In some cases 2 sets of figures are given to show the varying values of R; in the other cases the numbers are averages of all tests.

BARRANCA, province of Chancay, Peru, is to have a new waterworks system, recently authorized by law. Also, Lima is authorized to contract a loan of $18,000 for installation of a drinking water and drainage system, bonds being issued to cover the loan at not over 9 per cent interest.—Commerce Reports.

Efficient Operation of Boiler Rooms

FORMER REFUSE OF COAL MINES BECOMES EFFICIENT FUEL AT DOOR OF POWER PLANT

IN a Pennsylvania city of 60,000 inhabitants a public service corporation operates 2 power plants. These are located some distance apart and belonged at one time to competing companies which were consolidated. The outlying plant is well located in some respects, but is not central with respect to the load, and while well operated and in good condition, no extensive improvements have been made in a number of years nor are any contemplated. The other plant, however, is located in the heart of the city, and a great deal has been done in the way of adding equipment to increase the capacity, and a special study is being made to increase efficiency and reduce power cost. It is therefore the boiler room and operation of the centrally located plant that is described here.

From this plant, the company carries on a central station business, furnishing its customers with light and power, also steam heat in a limited district. At the time of our visit, this plant was being remodeled, considerable new machinery as well as instruments being put in, and methods of operation were necessarily being revised to suit the new conditions in the plant. There were in operation 3 400-hp. Erie City, 2 300-hp., 3 315-hp. and 1 600-hp. Edge Moor boilers. Two 1650-hp. B. & W. cross drum type water-tube boilers were being installed.

The boilers are all placed in steel frame work from which they are suspended, and incased in brick settings, 2 boilers to a setting, except with the new boilers, which are in single settings. The baffles are arranged to give 3 passes of the gas over the tubes and are made of fire brick, as are also the furnace lining and bridge walls. Under present conditions the boilers are operated at about 125 per cent of their normal rating, with one boiler kept to take care of variations in the load. During the peak load the boilers are forced to take care of 200 per cent of their factory rating. All boilers are served with McClave system of grates, which are placed on an incline about 4 ft. below the heating surface of the boiler.

Each boiler is provided with an alarm column, and these are blown down every watch. The flow of feed water to the boiler is regulated by hand. There are no fusible plugs in any of the boilers in this plant.

Some of these boilers have 2, some 3, and some 4 bottom blowoff connections, each one of which is provided with 2 valves. Some of the boilers also have surface blowoffs. The boilers are blown down once a week.

On each boiler drum is a 4-in. pop safety valve, which is set to blow at 150 to 152 lb., the pressure normally on the boiler being 125 lb. The valves are raised from the seats every 10 days to see that they are working properly.

As previously stated the McClave system of grates is installed under these boilers. These grates are of the dumping type and are placed in an inclined position, being fired by dropping coal from a hopper upon a hearth and spreading it with a wide hoe. Each of the furnaces is provided with 2 firing doors, and on either side of the hopper is a peek hole through which the condition of the fire may be seen. River anthracite coal is

used in these furnaces, which has a heat value varying from 12,000 to 12,500 B.t.u. per lb., and the depth of the fuel on the grates is from 4 to 12 in. With this coal the boilers evaporate from 5 to 6 lb. of steam per lb. of coal as fired. While the method of handling the fires is similar to that employed in hand firing, the labor is considerably less, the firing can be done much more evenly and the fire doors are not open as long as with a hand fired furnace.

Forced draft, produced by an Argand blower, automatically controlled to vary with the steam pressure, is employed under the grates. For controlling the draft over the fire and through the boiler setting a hand damper is located in the breeching of each boiler. The exact draft at the various parts of the setting has never been measured, so the fireman must judge from the looks of the fire how to handle his damper.

The feature of particular interest about this plant is the kind and source of coal used. In the early days of anthracite mining only that coal which was then of commercial value was shipped from the mines; coal dust and culm were dumped in piles outside the mines, on the banks of rivers and even in the rivers, to be carried away by the water. Now, as anthracite coal is becoming more valuable, and efficient means for burning this former refuse in power plant furnaces have been developed, this coal is being taken from the river beds with grab buckets. It runs rather high in ash, but is cheap and, as noted above, gives fairly good evaporation.

Coal is brought to the storage yard in wagons and weighed, then dumped into the hopper of a conveying and elevating system, which discharges in a pile in the coal yard. Beneath this coal pile is a tunnel provided with coal valves in the ceiling, which discharge into motor-driven industrial cars; these are hauled to the plant and, by means of an elevator, lifted to a track above the bunkers directly over the firing aisle of the boiler room. From the coal bunkers the fuel is discharged through chutes to the various boiler hoppers.

An estimate of the amount of coal used is made by counting the number of cars of coal used per day, and the bunkers are carefully graduated so that an estimate can be made each month of the amount remaining in the bunkers.

The amount of feed water delivered to the boiler is measured by means of a Lea V-Notch recorder in connection with a Cochrane open feed water heater. The load upon each boiler is indicated by means of a flow meter which is calibrated to read one-tenth the number of boiler horsepower developed, the calibration being on 30 lb. of steam per horsepower hour.

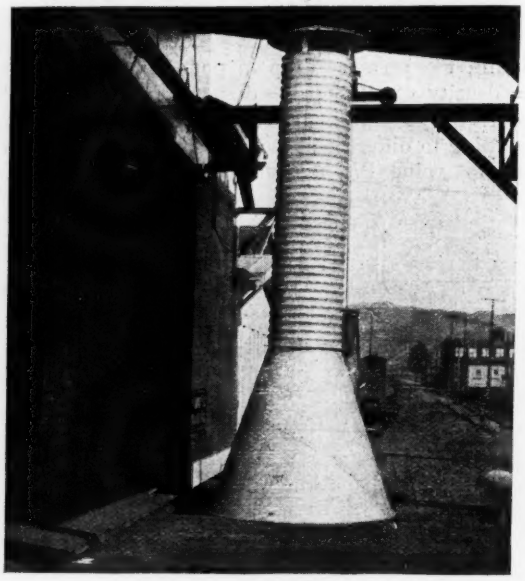
The feed water is said to be very hard, but is treated with a boiler compound which has given excellent results. By this treatment it has been found unnecessary to clean the boilers more than once a year.

Ashes are removed by means of the motor-driven industrial cars, which receive the ashes directly from the ashpit, and the car is then elevated to the ground level, or above an ash storage, from which it is delivered to railway cars or otherwise disposed of. The foundations of the boilers are such as to provide a soot pit back of the bridge wall, the contents of which is handled in the same manner as are the ashes. No trouble has been encountered in this plant with clinker.

Corrugated Iron Smokestack

By L. W. R. Allison

A SIMPLE and interesting type of smokestack has recently been erected on the roundhouse of the Yosemite Valley Railroad, Yosemite district, California. This stack, shown in the accompanying illustration, consists of a conical base of No. 14 gage iron; the connecting vertical stem is of corrugated iron pipe, 24 in. in diameter and 8 ft. long, of the same gage material noted, fitting into the bottom section as indicated in the reproduction. Five of these stacks were used for this installation.



CORRUGATED IRON SMOKESTACK FOR ROUNDHOUSE

Beyond the features of economy and practicability of this type of smokestack, interesting possibilities are present in such use of corrugated pipe; convenience and adaptability to the particular requirements are readily afforded where it can consistently and efficiently be employed along these lines.

Samples of petroleum oil have been collected from different parts of the country by the United States Bureau of Standards, and the specific gravity determined over a wide range of temperature. From the data obtained tables have been prepared for determining the true specific gravity and volume of oil at the standard temperature, when these quantities are measured at other temperatures. Tables have also been prepared for showing the relation between specific gravity, Baume degrees, and pounds per gallon.

The new tables will be especially useful in determining the quantity of oil in large shipments. These will very largely supersede the privately issued oil tables heretofore used. Circular No. 57 of the Bureau of Standards presents the results of these experiments, and it may be obtained by interested persons from that Bureau.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

Modern Electric Elevators and Elevator Problems*

CLASSIFICATION, INSTALLATION AND OPERATION; METHODS OF DRIVE AND CONTROL; POWER CONSUMPTION; SAFETY DEVICES. BY DAVID LINDQUIST

ELEVATORS may be classified according to the driving power employed: steam driven elevators; hydraulic elevators, and electric elevators.

Steam elevators are at the present time practically obsolete.

Hydraulic elevators may be divided into several groups, depending upon the different methods in which the hydraulic power is transmitted to the elevator car, some of the principal and well-known being the horizontal hydraulic (rope geared), the vertical hydraulic (rope geared), and the plunger hydraulic (direct connected). These have been mentioned in the order they were introduced for high speed in comparatively high buildings. The plunger type practically superseded other types of hydraulic elevators during the period of 1904 and 1907, and in turn the plunger has now been almost entirely superseded by the gearless 1:1 traction type of electric elevator.

Without considering in detail the technical features of the plunger elevator in comparison with the gearless electric traction type, the principal reasons for this change in elevator practice may be summarized as follows: (*a*) Higher initial cost of a plunger installation, (*b*) Larger amount of total space in the building occupied by the machinery, (*c*) Lower car mileage and consequently more elevators required for the same service, and (*d*) Higher power consumption.

LOCATION OF MACHINE

WHEN CONSIDERING the installation of the traction electric elevator the first question which arises is as to where the machine may most suitably be placed. There is no question but that placing the machine directly over the hatchway is the most suitable arrangement. With this overhead location the best results are obtained, and the principal advantages may be enumerated as follows: better traction, less amount of rope, longer rope life, minimum space required, and higher efficiency.

Placing the machine directly above the hatchway imposes a load on the building equal to the weight of the hoisting machine plus the loads on car and counterweight ropes, whereas placing the machine below, imposes a load on the building equivalent to twice the loads on the car and counterweight ropes.

Locating the machine above also takes up less space in the building than locating it elsewhere, prolongs the life of the ropes, as by this arrangement the rope is not subjected to so many bends and increases the overall efficiency of the installation.

ROPING

THE NEXT CONSIDERATION is that of roping. The roping of a so-called gearless 1:1 traction machine located overhead is extremely simple, as indicated in Fig. 1.

The principle of the traction drive is no doubt very old but its commercially successful application to an elevator machine, consisting of a slow-speed electric motor directly connected to the driving sheave, was first accomplished about 10 yr. ago.

At first glance, it would appear as if the traction drive would be rather uncertain, when considering that the ropes are not actually hitched to the driving member, that they simply go round the driving sheave of the motor, and depend solely upon the friction, or adhesion between the ropes and the driving sheave. This, however, is not the case; on the contrary, it is safer than any other method of drive.

Under ordinary conditions a 1:1 traction machine is usually provided with 6 ropes each ⅝-in. in diameter. The material is of soft steel, and in actual installations this will give a safety factor of not less than 12. Each rope is provided with a self-adjusting swivel rope hitch of the ball and socket type. This permits a gradual creeping and thus prevents any excessive twisting strain, and relieves the rope of the bending strains at the hitch, principally caused by vibration.

The traction method of drive has a number of inherent safety features. Traction elevators are arranged so that in case of overrun at terminals, either the car or counterweight bottoms on a buffer, thereby reducing the traction sufficiently to prevent further motion of the car and counterweight, even if the motor keeps on running. The car buffer is usually an oil buffer of a spring return type and mounted in the bottom of the pit, as illustrated in Fig. 2. As shown in Fig. 1, the counterweight buffer is mounted on the counterweight, and acts also as counterbalance. This latter buffer has gravity return, whereas the car buffer has spring return.

For exceedingly high rises, the great weight of the hoisting rope will cause considerable traction, even after the car or counterweight has landed on its buffer. This traction, together with the momentum of the car or counterweight, may cause either of them to travel into the overhead work, under conditions of runby clearance

*From a paper read before the A. S. M. E.

usually available. To prevent this, some of the exceedingly high-rise buildings are equipped at the top of the hatchway with a retarding and latching device for both car and counterweight, in addition to the regular oil buffers acting in the pit. In case of abnormal overrun, the retarder brings either car or counterweight to rest and the latching device prevents subsequent downward movement.

Counterweight and Rope Compensation

The counterweight equals in total weight the weight of the car plus usually about 40 per cent of the maximum load. If we consider an elevator of 2500 lb. lifting capacity, 40 per cent of this equals 1000 lb., the

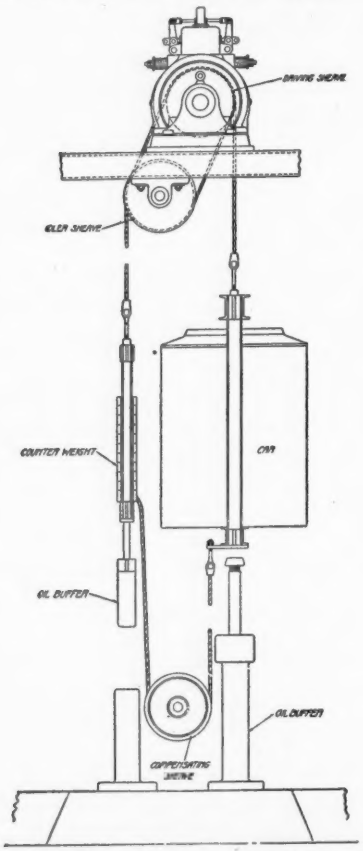


FIG. 1. DETAILS OF THE ROPING OF A TYPICAL GEARLESS 1:1 TRACTION ELEVATOR

weight of about 6 or 7 persons. Thus, with 6 or 7 persons in the car, giving balanced condition, it is apparent there would be no net load to be lifted and the only power required would be for acceleration and for overcoming friction and electrical losses.

It is obvious that with a high-rise elevator the variation in the net load on the elevator machine, due to the shifting of the weight of the hoisting ropes from one side to the other of the driving sheave as the car moves up and down, would be excessive if this were not compensated for. This compensation is usually obtained by means of chains or ropes attached to the car and counterweight, and running down the hatch in a loop. In Fig. 1 may be seen the compensating ropes running down from the bottom of the car to the tension sheave in the pit and up to the counterweight. The weight per foot of these compensating ropes is such that they, together with the electric cables that lead to the car, will compensate the weight of the hoisting ropes regardless of the position of the car.

For all high-speed high-rise elevators, compensating ropes are used. In the pit a tension device is provided for the compensating ropes. For moderate rises and comparatively slow speeds, chains may be used instead of ropes.

Driving Motor

The electric motor is of the slow-speed type, generally 6-pole and usually provided with shunt field only. The armature is series-wound with conductors of rectangular cross section, in order to get the maximum amount of copper in the armature. With a 36-in. driving sheave, a car speed of 600 ft. per min. corresponds to 63.6 r.p.m. of the motor.

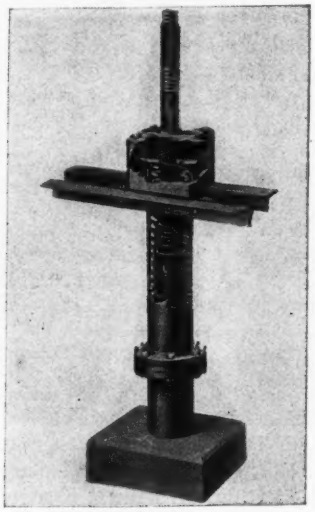


FIG. 2. DETAIL VIEW OF CAR BUFFER OF THE SPRING RETURN TYPE

Up to even a comparatively late date, it seems to have been the general impression that a motor of moderate duty, having a speed so exceedingly low as that required for this gearless type of elevator, would have also a low efficiency; but this is not the case. On the contrary, it has been demonstrated, and proven a number of times, that a motor with this low speed can be designed to have just as high efficiency as any high-speed motor of equal output. One peculiar feature about the efficiency of this motor is that it is unusually high at light loads, a particular advantage in connection with elevators where the average load on the motor is usually less than ½ its rating.

The driving sheave is commonly about 36 in. in diameter, and the driving sheave and brake wheel are of the rim type, cast integral and bolted to the armature sleeve or spider. Circular rope grooves are employed. The brake is of the shoe type, and the magnet is usually provided with series-winding for quick release, and with a shunt-winding for holding. The brake shoes are provided with a lining of fabricated asbestos. A gradual

and soft application of the brake is obtained by a particular method of magnetic retardation of the magnet cores, eliminating thereby the necessity for dash pots. The brake shoes were formerly, for some time, lined with leather, but after exhaustive tests of a number of different brake lining materials, it was found that a certain kind of fabricated asbestos was the most suitable. The particular quality or characteristic of this brake lining is that the friction between the lining and the wheel is practically constant at all times. Tests have been made and the temperature ran up to about 400 deg. C., but there was no appreciable variation in the friction. Furthermore, the coefficient of friction is constant, varying but little with variations in speed. The variation is remarkably small as compared with leather.

Bearings

The bearings are either of the ordinary babbit lined, self-alining type, with automatic chain-oiling or are of the anti-friction ball or roller type. Elevators of the gearless traction type have been for some time equipped with ball or roller bearings, which are used for both the main motor, and rope sheave bearings. They were adopted primarily to gain space, and it is readily apparent that these anti-friction bearings take up much less room than the plain solid bearings. It followed therefore that a traction machine equipped with them could be designed to take up less space and thus, in many instances, eliminate the necessity for double decking an installation consisting of a number of adjacent elevator machines; by "double decking" is meant the placing of machines on 2 levels, when the machine is longer than the center distance between adjacent hatchways, thus preventing their installation on one level.

In the case of elevators with 2:1 roping, this saving in space in connection with the sheaves, really becomes a necessity; for here, particularly in the counterweight sheave where space conditions are always limited, a plain babbit bearing of suitable capacity would be practically impossible. Of course, the use of these anti-friction bearings also introduces other decided advantages—materially reducing friction, particularly at starting, and introducing a smoothness of operation superior to plain bearings. This is again particularly applicable to the sheaves used with machines having 2:1 roping, for here the additional number of sheaves requires that the friction be reduced to a minimum.

(To be continued.)

Operation of Rectifier Tubes

By J. L. Tolman

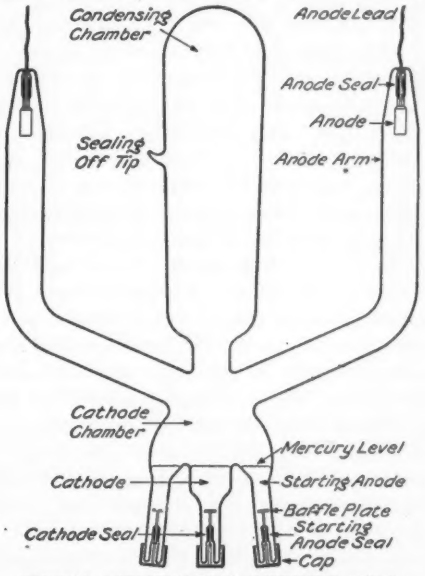
When I had the care of 14 rectifier tubes used in the operation of a street lighting system, I succeeded in reducing the expense for tubes over 50 per cent. I found that a large number of them were discarded because of the breaking off of one or both of the anode leads close to the seals.

This breaking of leads is caused by the bending back and forth when starting and also when the tubes are washed. These leads may also be broken by connecting them too short to the tube carrier, the short lead bringing the tube to a stop when it is rocked back and forth in starting. At first it was a rather difficult job to solder these leads on again, but I have found that a perfect electrical contact and a secure mechanical connection can easily be made.

The most successful way of doing this is to take a piece of solid copper wire about 2 in. long and about 1/25 in. in diameter; and sharpen one end to a long tapering needle point. The broken end or ends of the leads must be thoroughly cleaned, which requires a little patience as they are hard to reach when broken off close to the glass. Although this is usually the case, the work can be done with almost any tool having a sharp point.

After the broken end of the lead is cleaned, the piece of solid copper wire should be lightly driven as far as it will go into the end of the tube alongside of the lead. A small amount of some good soldering compound should then be run down around both. In doing the soldering, the solder should be somewhat hotter than usual, for if it is not, it will not run down into the small spaces as it should.

If a large drop of solder is dropped around the wire, and the point of a hot soldering iron held against it for a minute or 2, the solder will enter the small spaces, resulting in a good job. After this, it is but a simple matter to solder a piece of flexible braided wire, of the same metal as the leads, to the end of the piece of solid copper wire. After a little practice, it should not require over 15 min. to solder the leads on a tube.



TYPICAL MERCURY-ARC RECTIFIER TUBE

One of the ways to lengthen the life of rectifier tubes is to wash them at least once in 2 weeks, something in the line of soap being used in the water to remove any deposits from the oil that may be on the outside of the glass.

The water should be hot enough so that when the tube is removed from the water a slight tapping or shaking will cause a large portion of the condensed mercury on the glass to fall to the bottom of the tube with the rest of the mercury. After the tubes are washed, they should be allowed to dry thoroughly before being placed in the oil.

Proper use of static protectors will also prolong the life of a tube. Quite often a tube will fail to operate, but as soon as a set of static protectors are put on, the tube will often operate satisfactorily for a long time.

The practice of resting tubes that fail to operate or of resting the tube as soon as it shows the first sign of unsatisfactory operation will also prolong its life. This will give the best results if systematically followed, that is, after a tube has run a certain predetermined number of hours, it should be rested for a certain length of time and so on throughout its life.

The method of heating or baking tubes in an oven to a temperature of 200 or 300 deg. C. may in a shorter time accomplish the same results as resting. This, however, is not always convenient.

Improper oil temperatures will shorten the life of a tube about as much as anything. The nearer the oil temperatures are kept to about 80 deg. F. the longer the tubes will last. By careful hourly regulation of the cooling water valves, the temperature can be kept between 78 and 82 deg. F. Tubes will stand considerable extremes of temperatures; but I have known them to lie down, or drop their load from no other apparent reason than high or low oil temperature, the same tube operating for months afterwards when the oil temperatures were kept within reasonable limits. This and other experiences prove that the life of a tube will be greatly shortened by improper oil temperatures.

Tubes may also be broken by a strong, quick jerk of the starting or shaking device, the inertia of the tube causing one or both of the anode arms to break off. This is not so likely to happen to tubes that are started by an automatic shaking magnet, but may happen in cases where the tubes are started by hand shaking devices.

The construction of the light circuits has more or less influence on the life of the tubes. For instance I had one circuit on which the tube consumption was 100 per cent greater than for the other circuits for no other apparent reason than the fact that the lighting circuit wires were carried for several miles close to a 6000-v. transmission line.

A tube no matter how old, is not hopeless unless it has lost its vacuum or is broken. I had one tube that operated for over 9000 hr., the average life being with fairly good care 5000 to 6000 hr.

As a rectifier tube is quite expensive, it is profitable to handle and operate them with care, or at all events it is profitable to the man who has to pay the bills; and care, in these and similar things, is generally profitable to the operator in the long run.

AMONG THE requirements for government supplies for the Navy Department, for which sealed proposals are invited, are noted horizontal centrifugal pumps, schedule 9382; variable speed gears, 9383; electric traveling hoist, 9384; wire-wound rubber steam hose, 120-volt electric heaters, steam traps and reducing valves, schedule 9398; worm-geared chain blocks, 9402; 5-kw. radio motor generators, with contractor type automatic panels and radio transformers, schedule 9405.

Details can be obtained from the Bureau of Supplies and Accounts, Navy Department, Washington, D. C.

Some Problems of the Panama Canal

GEOLOGY and topography in their relation to Panama Canal engineering problems are discussed in Bulletin 86 of the United States Bureau of Mines just issued. Donald F. McDonald, the author, was detailed as geologist to the Canal, while it was under construction, and is now with the Bureau of Mines.

As to the stability of the estimates of Panama, Mr. McDonald says, "In all, there is a clear record of 4 oscillations and the beginning of another elevation. Hence the question, 'Is the canal in danger from this uprise?' Should the rise be rapid, of course it would be in some danger; but the fact is, that the average rate of uplift for, say, the last 1000 yr. has been something less than 3 ft. in 100 yr.

"It is believed that the sinking of the ocean bottom outside the relatively shallow depths of the isthmian shore waters has been the chief cause of the earthquake periods that have, so far as the records go, visited the isthmus every 30 to 35 yr., and that each of these seismic disturbances has resulted in some increased uprise of the land mass.

"Culebra Cut is a vast ditch that passes through many varieties of rock in the 9 miles of its length. Some of these are weak and unstable, and where the slopes of the cut were steep and 100 to 300 ft. high, the weaker rocks locally crushed down to flatter slopes. The flatness depended on the material involved, but, whatever the material, whenever the slope got flat enough the sliding stopped. At no time did the engineering staff constructing the canal believe that the slides were a menace to the ultimate completion and successful operation of the canal, in spite of the fact that at times they were somewhat troublesome. Excavation has been necessary of about 30,000,000 cu. yd. more than was included in the first estimates for Culebra Cut, but this has not in the past and will not in the future endanger the ultimate success of the canal.

"The largest and most important slides developed from structural breaks and deformations. Fortunately, they occurred only near Culebra in a section of the cut not much over a mile long. These deformations first manifested themselves by the appearance of one or of a set of cracks or fissures parallel or somewhat oblique to the edge of the cut, and from a few yards to some hundreds of yards back from it and from each other. Some of them were traceable on the surface for several hundred yards and gradually developed into perpendicular crevices up to one-third of a yard wide and many yards deep.

"The chief slides due to structural breaks have taken place in that part of Culebra Cut lying between Gold Hill and Empire Bridge. On the west side in this section of the cut sliding began in October, 1907, and extended so that in all over 70 acres of material moved or was seriously cracked.

"Though it is not impossible that a destructive earthquake might visit the canal, it is extremely improbable, and the following are the chief reasons why it is believed the canal will never be in any appreciable danger from earthquakes.

"1. The large number of tremors detected every month by the recording instruments is evidence that slow adjustments are constantly taking place and thus that no great accumulations of stress that might later culminate in a big shock are probable.

"2. Absence from the Isthmus region of high mountains and of geologically recent volcanic activity is evidence in favor of the probable absence of earthquakes, especially as such high mountains are a striking geologic feature of the whole Central American earthquake belt.

"3. The presence of numerous small faults and of the faulted conditions of such volcanic cores as Gold Hill and Contractors Hill is evidence that adjustment here has progressed well on toward normal conditions of equilibrium.

"4. The tensile strength of the majority of the rocks within the Canal Zone is rather low, and they would shear with comparative ease, thus preventing any relatively great accumulation of stress that might result in a comparatively intense shock. Experience teaches, however, that where earthquakes happen the buildings suffering the maximum destructive effects are those built on loose and friable material. This consideration might therefore subtract a little from the saving benefits of the yielding and preventive qualities of the Canal Zone rocks.

"5. Over 300 yr. of earthquake observation shows only 2 shocks of considerable magnitude, and there is every reason to believe that the severest of these would not have seriously damaged even the most delicate parts of the canal.

"That many small and harmless shocks will traverse the Canal Zone is certain, but that the canal is in any real danger from earthquakes is contrary to all the evidence."

Mobilizing Our Industries for Defense

WITH the full authority of President Wilson and the Secretary of the Navy, the Associated Advertising Clubs of the World, touching American business at practically every point, have placed their entire organization squarely behind the nation-wide plans of the Committee on Industrial Preparedness of the Naval Consulting Board of the United States, and a specially appointed committee of leading publishers and advertising experts will shortly start a campaign in the newspapers and magazines of America in support of the work of the Committee on Industrial Preparedness.

The plan provides for the active co-operation of this organization with the 30,000 engineers who will soon undertake the tremendous task of making a card index survey of American industry, so that it may be prepared for national defense if need comes. Herbert S. Houston, president of the A. A. C., says:

"This is not a war measure, but a peace measure. The militarist will support it and so will the pacificist, as well as the great body of Americans in between. So we have adopted as the slogan of the campaign 'National defense and international peace,' believing that the two causes will be best served by linking them together.

"While the primary thing, of course, is service to the country, it is manifest that this work of the engineers will be of the greatest service to industry in times of peace. If industry is mobilized for defense, it will be placed on a basis of efficiency to meet the keen competition that will surely follow the present war. So this work of the engineers for industrial preparedness means insurance against war and insurance for prosperity in time of peace."

Mr. Coffin, one of the leaders of the American automobile industry, in outlining the far reaching plans of his committee, made the following statement:

"At the outset I wish to emphasize the absolutely nonpartisan nature of this work. I am not even familiar with the political affiliations of the great majority of the members of the Naval Consulting Board or of my committee. In setting out to mobilize the industrial resources of the United States, we are concerned only with the benefit to the nation, and to that end we have called into being an organization made up of the best technical and business brains of the country.

"It is vitally necessary that American industry be made aware of the part it must play in the national defense. Our whole conception of warfare has been changed almost overnight.

"The European war has driven home to us that battles are now won not alone by fighting men, but by the fighting industries of a nation. It has all come down to which country can fastest and longest supply the munitions of war to the men on the fighting line. It has come down to the question of which country can fastest and in the greatest quantity supply shells to the guns—to speak of only one item of modern warfare.

"Now when warfare gets down to this basis, it becomes not merely a question of the ability of army and navy heads; there is brought into action every bit of industrial brains of a country. In approaching the entire broad problem of industrial preparedness, special pleadings in oratory or in print are not sufficient. There must be a plan, and it is a very definite practical plan on which this committee has been engaged for the past 3 mo., and which is even now under way.

"There are 3 distinct initial steps. The first is to find out what American industry can actually produce in munitions of war. The second is to apply that knowledge in a practical way which will put the plants of this country into the service of the government behind the army and navy. The third step is to form such an organization of skilled labor as will not get off the job when war comes, that will not allow skilled workers to go to the front only to be pulled back later, more or less demoralized, to tasks from which they should never have been taken.

"In the first step, that of making the industrial inventory, we cannot depend on any small corps of men or board. The work must be done by the men who themselves have developed the industries of the country. Briefly, in every state of the union a board of 5 directors has been formed, each director being a leading business engineer of his state, familiar with his state's factories, mills and mines. This gives us, including Alaska, 5 men each in all 49 working boards of 245 engineers of the highest standing, and under them will work the more than 30,000 engineers belonging to the 5 great societies, all of these men trained as only American engineers are trained. All the state directors, from

Maine to Alaska, and from Louisiana to California, have accepted their nomination. The engineers are entering upon the work in the most serious and concentrated frame of mind.

"The method of procedure will be that under the direction of this committee and immediately in charge of W. S. Gifford—a minute, sweeping inventory of industry will be made by means of a carefully prepared printed form. The information called for in this form will be based upon what business men consider it necessary to know in arriving at the physical capacity of plants and their fitness and reliability for specific classes of output. Such information has never before been collected by any department of the government. This form has been passed upon by the army and navy authorities, and the inventory will probably be made during the month of May. Nothing has been left to guess work. The program is the fruit of months of work and consultation with the best brains in the country. Everything is now ready for rapid movement.

"But—and here we come to the second step—we will not stop at the mere gathering of this information. The detailed record of producing facilities, for that is what it will be, will not be enough for our purpose. We have accepted in the gravest spirit the lesson written in the industrial upheaval and in some instances the industrial paralysis that seized upon some of the nations at the start of the European war. We must not wait for war before we mobilize our resources. Therefore we have formulated a specific feasible plan whereby the manufacturers of the United States in times of peace shall maintain an annual minimum production of that part of the munitions of war best suited to their respective outputs.

"To illustrate, suppose that we go to a great automobile company with an order for 10 3-in. shell casings per year, to be produced at any time during the year, on the procedure that those casings must be delivered every year. Even an insignificant step like this will insure our purpose. The purchasing department of the company will learn how and where to buy materials; the manufacturing department will learn how to handle them; it will become familiar with the necessary jig and tool equipment, and with the heat treatment and with the standard of inspection; the engineering department will have the up-to-date blue prints and specifications on file, and all arguments will be gotten out of the way during the period of peace.

"The minimum annual educational orders will be paid for by the government on the basis of a reasonable but not excessive rate of profit to the manufacturer. This is a matter of common national endeavor; it goes straight to the best interests of manufacturers and laboring men alike, and in the United States, with the greatest producing resources in the world, there can be no better national insurance against war.

"Let me also point out one very vital thing; this annual distribution of orders will develop our industrial resources for war nationally, in a geographic sense. It will bring to the support of the army and navy industrial centres west of the Alleghanies and away from the exposed seaboards.

"And let me say, finally, that this plan will not only insure against the shutting down of plants in time of war, but will give employment to the maximum number of working men throughout the country even under war conditions, and will prevent suffering through unemployment."

Bascom Little, President of the Cleveland, Ohio, Chamber of Commerce, and Chairman of the National Defense Committee of the Chamber of Commerce of the United States, said: "The thing that has stirred up the business men of the middle west during the past eighteen months has been the lesson they have learned in the making of war materials. It points a vivid moral to all our people. It all looked very easy when it started a year and a half ago. The plant with which I am associated in Cleveland got an order for 250,000 3-in. high explosive shells. It was a simple enough looking job, just a question of machining. The forgings were shipped to us and we were to finish and deliver. It began to dawn on us when the forgings came that this whole order, that looked so big to us, was less than one day's supply of shells for France or England or Russia, and we felt that in 8 mo. by turning our plant, which is a first-class machine shop, onto this job we could fill the order. In a little while we got up against the process of hardening. That—and mark what I say—was 14 mo. ago. To date we have shipped and had accepted 130,000 shells, and those, about half our order, are not complete. They still have to be fitted by the fuse maker, then fitted in the brass cartridge cases with the propelling charge, and somewhere, sometime, maybe, they will get on the battlefield of Europe. Up to the present none of them has arrived there.

"Now this is the situation in a high-class, efficient American plant. This is what happened when it turned to making munitions of war. The same thing has occurred in so many middle western plants that their owners have made up their mind that if they are ever going to be called upon for service to their own country they must know more about this business. They feel that they are now liabilities to the nation and not assets in case of war.

"The Defense Committee of the U. S. Chamber of Commerce has been trying to figure out what sort of relation these private plants should have to the Federal Government in time of war, and we have reached the fundamentals of a plan.

"We feel that there should be, in the first place, a contract made in the open market as we would do business with any other customer, with this main difference: that in case of war there should be no excess profit to anybody arising out of the national necessity, and that the Federal Government should have the use of the private plants of the country in war time at a living wage to the stockholders. It is economically unwise that the stockholders should cease to have dividends from their investment, but the Government should have the right to take over the plants, with their personnel and equipment, on the basis of a living wage, so as to prevent the creation of a profit interest in war.

"We feel that it is very dangerous and un-American to set up any kind of system which will make any part of the community interested in forcing the nation into war, and that if there be war, every person, high or low, in this country must accept his share of the national sacrifice and with all his heart and head work in whatever place his ability can best be applied."

Internal Combustion Engines and Coal Gas Producers

ACCORDING to the 1915 edition of the Regulations of the National Board of Fire Underwriters relative to the installation and use of internal combustion engines and coal-gas producer systems, stationary gas, gasoline, kerosene and fuel-oil engines should, wherever possible, be located on the ground floor and, if in workshops or rooms where dust or inflammable flyings prevail, must be enclosed in a suitable compartment well ventilated to the outer air at floor and ceiling. If placed on a wooden floor, the floor under and 24 in. outside of the engine should be covered with metal.

The supply tanks used in connection with portable engines must be so located, or protected, as to avoid injury from coming in contact with outside objects, as well as to prevent excessive rise of temperature of the gasoline, due to heat from cylinder or exhaust, and should be so mounted as to be protected against wear due to jarring and vibration. All pipe connections should be made above the highest gasoline level in the tank. The capacity of the tank should not exceed the amount of fuel required for a 10-hr. run at full load, and under no conditions should gravity feed from supply tank to engine be employed.

Exhaust pots of the closed type must be provided with plugged opening placed near the bottom and below the exhaust-pipe connection, and of whatever type, must be placed on firm foundations. Mufflers and exhaust pots must be kept at least 1 ft. from woodwork or other combustible materials.

No exhaust pipe shall be within 9 in. of any wooden lath and plaster partition, ceiling or other combustible material, and whether direct from engine or from mufflers, shall, where practicable, be carried above the roof of the building in which the engine is contained; where too high to make this practicable, the pipe shall end at least 10 ft. from any wall opening.

Where exhaust pipes pass through combustible partitions, they shall be guarded by ventilated galvanized-iron thimbles at least 12 in. larger in diameter than the pipes, or by galvanized-iron thimbles built in at least 8 in. of brickwork or other noncombustible material. They shall under no circumstances be connected into chimneys or flues, except that the pipe may pass up in flues used for no other purpose. No exhaust pipe shall pass through any floor, nor through a roof having wooden framework or covering.

In the case of kerosene and fuel-oil engines, water pockets in exhaust pipes are to be provided with suitable means for drainage.

The gasoline feed cup of stationary or portable engines must be arranged to prevent spattering, dripping or exposure of gasoline, and must be provided with an overflow connection draining to the supply tank. The gasoline feed pump must be of approved type, secure against leaks, with check valves located as close to the pump as convenient.

For kerosene or fuel-oil engines, torches used for initially heating the combustion chamber must be of a type approved for use with kerosene and are to be used only while starting the engine. The pressure on the supply reservoir is to be released as soon as the engine is firing properly.

The gasoline supply for engines using this liquid for starting must be drawn from an outside underground storage tank by means of a hand pump attached to the engine, into an approved feed cup having a capacity of not more than 1 pint and provided with an overflow to the outside gasoline tank; or an approved reservoir of the "lift out" type may be used, provided its capacity is limited by the quantity necessary to produce a proper temperature for operating the engine with the heavier oils, but not to exceed 1 gal.

Coal Gas Producers

ALL PRESSURE SYSTEMS must be located in a special building or buildings, at such distance from other buildings as not to constitute an exposure thereto, except that approved pressure systems without gasometer having a maximum capacity not exceeding 250 hp. and with pressure in generator not exceeding 2 lb., may be located in the building, provided that the generator and all apparatus connected therewith be located in a separate fireproof room, well ventilated to the outside of the building; every communication, if any, to be protected by an approved fire door.

Approved suction gas producers may be located inside the building, provided the apparatus for producing and preparing the gas is installed in a well-ventilated room.

The smoke and vent pipe shall, where practicable, be carried above the roof of the building in which the apparatus is contained, and above adjoining buildings. When buildings are too high to make this practicable, the pipe shall end at least 10 ft. from any wall opening.

No smoke nor vent pipe shall be within 9 in. of any woodwork or any wooden lath and plaster partition.

Where smoke and vent pipes pass through combustible partitions they shall be guarded by ventilated galvanized-iron thimbles at least 12 in. larger in diameter than the pipes, or by galvanized-iron thimbles built in at least 8 in. of brickwork or other non-combustible material. They shall not, under any circumstances, be connected into chimneys or flues except that the pipe may pass up in flues used for no other purpose. No smoke pipe shall pass through any floor nor through a roof having wooden framework or covering.

While the plant is not in operation the connection between the generator and scrubber must be closed, and the connection between the producer and vent pipe opened, so as to allow the products of combustion to pass into the open air. This must be accomplished by means of a mechanical arrangement which will prevent one operation without the other.

Wire gauze not larger than 30 mesh to the inch or its equivalent must be used in the test-pipe outlet.

If illuminating or other pressure gas is used as an alternative supply, the connections must be so arranged as to make the mixing of the 2 gases or the use of both at the same time impossible, although if illuminating or other pressure gas is used as a supplementary supply, mixing of the 2 gases may be permitted if a suitable device is provided to prevent the supplemental gas from entering any part of the producer-gas equipment, including the scrubber or purifier.

The opening for admitting fuel shall be provided with some charging device so that no considerable quantity of air can be admitted, or gas escape, while charging.

Before making repairs which involve opening the gas passages to the air, the producer fire must be drawn and quenched and all combustible gas blown out of the apparatus through the vent pipe.

Trouble With New Piston

AN 80-HP. gas engine needed a new piston badly, as all wearing parts were entirely worn, and the back end was badly cracked. We sent it to the city to have a new one made, which after some waiting came to hand, and as all load had been put on the other engine, we hurried to get the piston in place so as to give time to take down the second engine and put in new gaskets and give it a greatly needed cleaning.

After the new piston was in, we started up the engine and put some load on it, but we got mostly smoke and noise. Heat caused the new piston and rings to expand so much that running was out of the question, as even at no load with a few light explosions the piston ran hot. With a small stream of oil we kept it running at no load for 6 hr., thinking this would give time to wear the piston into place. Then a spring broke on the other engine, and we had to throw the load on the one with the new piston; but after 5 min. this got as hot as before, making the same outlandish noise and unlimited smoke.

We had to keep it running, so opened the oilers to run full stream, and that cylinder oil was just making smoke fine. We tried all kinds of automobile and cylinder oils by drops and by streams, but the result was the same. Then we took the oilers off and poured castor oil into the cylinder, but this was only a little improvement. The piston was so hot that no kind of oil was of any advantage.

In this case, necessity forced invention. I cut a candle into small pieces and placed them on the hot cylinder around the edges of the oiler holes, so that the grease, in melting, would run to the piston. To the surprise of everyone, the smoke and noise vanished. For half an hour I kept putting pieces of candle on as fast as they melted, then put the oilers back in place, filled with common cylinder oil, and everything ran finely. The candle grease was the right lubricant, and while working under this treatment the high spots of the piston wore off. We did not have to stop, but obviously we took a big chance. CHAS. LABBE.

Why Centigrade?

BY J. C. HAWKINS

A STATE of affairs which causes considerable trouble and which is receiving the attention of all who have to do with temperatures, is the unsatisfactory Fahrenheit scale of temperature measurements, which is little used outside of America and England, as it is inferior and more complicated than the Centigrade scale. In fact this should be brought to the attention of Congress and the standard scale changed from Fahrenheit to Centigrade.

The freezing point of water as recorded on the Fahrenheit scale is 32 deg. above zero, and the boiling point is 212 deg. above zero, or 180 deg. above the freezing point. On the Centigrade scale, the freezing point is zero, and the boiling point 100 deg. above zero, or 100 deg. above the boiling point. These 2 points, freezing and boiling, are the points where water changes in one case from a liquid to a solid, and on the other extreme from a liquid to a gas. These points are important and should be designated by a significant figure. The temperature can, of course, be extended above or below these points, but what legitimate excuse is there to say that water which is used as a standard changes from one state to another at 23 or 45 or 32 or any other number of degrees above zero. When we speak of the temperature of boiling water we do not refer to 32, but to the temperature above zero.

There is, however, another zero point or absolute zero of temperature, or the point at which there is no molecular motion of any substance, which is 460.6 degrees below the zero of the Fahrenheit scale, or approximately 493 Fahrenheit degrees below freezing point.

We who are accustomed to using the Fahrenheit scale know that when the thermometer reads below 32, the temperature is low enough to freeze water. If it is, say, down to 20, it is 12 deg. below the freezing point, but we still call it 20 deg. above zero, and not 12 deg. below freezing. Why? We do not know whether it is above or below the freezing point until it is compared to an entirely different figure, and one which has no special significance. The same may be said of the boiling point.

With the freezing point taken at zero and the boiling point at 100, as is done on the Centigrade scale, the temperature reading tells whether the temperature is above or below the freezing or boiling points of water. That is, 22 deg. C. means that the temperature is 22 deg. above freezing, and 110 deg. means 10 deg. above the boiling point of water when atmospheric pressure is 14.7 lb. per sq. in.

The Fahrenheit scale has one advantage, however, for engineer's work, and that is that the range of temperature between freezing and boiling points of water is divided up into 180 units, whereas in the Centigrade scale it is only 100, or 5/9 as many units. This allows the temperature to be read more closely on the Fahrenheit scale without involving the use of fractions, which would invite error, and which in many cases is important.

This advantage is more than offset, however, from the engineer's point of view when he is called upon to figure the percentage of moisture in steam, for instance, or the factor of evaporation, or other problems having to do with the temperature and heat of water, both as a liquid and gas, and where the freezing and boiling points must be considered.

Although the Centigrade thermometer is now universally adopted by scientists of all countries, year after year hours of valuable time are lost converting Fahrenheit into Centigrade, and vice versa, in making calculations.

Congress should instruct the use of the Centigrade scale in the weather bureau; it would then soon become universally used in this country, much to the relief of those who have to deal with temperatures. True, there might be some confusion while the change was being made, but when the fact is kept in mind that 1 deg. C. is equal to 9/5 deg. F., the idea is not so difficult to grasp and the better method would soon become familiar.

Steam Boiler Efficiency

INFLUENCES THAT AFFECT FURNACE AND BOILER EFFICIENCY AND INSTRUMENTS WHICH GIVE GREATEST AID TO FIREMEN. BY E. A. UEHLING

ALMOST invariably official boiler tests, made by or under the direct supervision of experts, show from 10 to 20 per cent greater efficiency than is obtained from the same boilers in every-day practice. This raises the question, can the high efficiency obtained by an expert be at least approximately maintained in every-day practice? If so, how can it be accomplished? What does the expert do to get his results?

1. He analyzes the coal, (a) for the purpose of ascertaining its heat value; (b) to be able to establish a heat balance; (c) to get a line on how to burn it effectively. Is there any reason why every large coal user should not have his coal analyses at regular intervals? If for no other reason than to know whether he is getting what he is paying for?

2. He brings with him one or more expert firemen, or selects the best available from the existing staff, and generally pays him extra to insure good work. Good firemen are therefore essential and considered worthy of extra pay. Poor firemen are expensive working for nothing. Is there any reason why good firemen should not be available if the proper inducements be offered?

3. He makes sure that the boiler is clean, inside and out, that the grate bars are whole and straight and suitable for the kind of coal to be burned. He sees to it that there are no cracks and crevices in the boiler walls and that cleaning doors close tight.

It is therefore essential that the boilers be kept clean and in good order, and especially that air infiltration be prevented. It should not require an outside expert to insure that the boilers be maintained in good condition.

4. He brings with him a staff of assistants. One keeps a careful record of the weight of the coal fired; but that does not increase its heat value. Another accurately weighs or measures the feed water; but that does not increase the evaporation. Another analyzes the flue gas and notes its temperature. Another tests the steam generated for entrained water or superheat. Many other data are noted and recorded, all of which are necessary to enable the expert to calculate the efficiency of the boiler under test and to strike a heat balance. But with the exception of those pertaining to the composition and temperature of the flue gas, none of the data noted and recorded by the staff of assistants are of the least aid in attaining high efficiency. And since the 2 essential elements in the flue gas records, viz., CO_2 and temperature, can be autographically recorded and continuously indicated by appliances readily available at reasonable cost, an expert and corps of assistants are not required to assure economical boiler operation in every-day practice.

ESSENTIALS FOR HIGH ECONOMY

SIFTING THE essentials from the non-essentials in the program of the expert boiler testing, we have:

(1) Clean boilers; (2) tight settings; (3) skillful firing; (4) knowledge of the chemical composition and physical properties of the coal used; (5) furnace adapted to the fuel used; (6) draft regulation; (7) continuous knowledge of the per cent of CO_2 contained in the flue gas, also its temperature at the point where it leaves the boiler.

The first five of these conditions essential to boiler efficiency should be quite self-evident.

(1) It should not require the services of an expert to keep the boilers clean, yet a great deal of coal is wasted because of dirty and scaly heating surface.

(2) Tight boiler settings are the exception rather than the rule. Should an expert and a staff of assistants be required to keep the setting tight? Certainly not. It is nevertheless a deplorable fact that air infiltration is one of the most prolific causes of low boiler efficiency. It is stating it conservatively to say that in the average boiler plant the amount of air drawn in through numerous cracks and crevices is 20 to 30 per cent of the air passing through the fire and furnace, and that there are many more boilers in which the air infiltration is over 30 per cent than those in which it is below 20 per cent. Since the air so entering cannot aid combustion but is all heated to the stack temperature, it follows that 25 per cent of air infiltration will increase the heat wasted up the chimney by just that much.

(3) Knowledge of the chemical composition and the physical properties of the coal used is necessary not only for the expert that he may determine the proper design of furnace, etc., but it is valuable for the every-day operation as well. Every material change in the chemical and physical property of the coal requires a change in the method of firing, the frequency of cleaning the fire, the strength of draft, etc., a correct knowledge of the chemical composition and physical properties of coal used will therefore be of material assistance in attaining a high efficiency in every-day practice.

(4) Every steam engineer of experience knows that the furnace and grate bars must be adapted to the kind of coal available, if good results are to be realized. It may, and generally does require the services of a combustion expert to determine the grate and furnace construction best adapted to burning a given fuel; but when these conditions are once established there is no good reason why they should not be maintained in every-day practice.

(5) Draft regulation is a most important factor in the proper operation of a steam boiler, and probably the least understood. Draft is the force which impels the air through the fire and the products of combustion through the boiler and up the chimney. Draft, whether natural, forced or induced, is manifested by a difference in pressure. The effective draft is the difference in pressure between the air under the grate bars and the gases on leaving the boiler; it is composed of 2 parts, viz., the furnace draft and the boiler draft. The former is the pressure difference between the ashpit and the furnace, and the latter, the boiler draft, is the pressure difference between the furnace and the uptake. The boiler draft varies directly with the volume of gas coming from the

furnace, hence for the same rate of combustion it varies inversely as the per cent of CO_2 in the flue gas, and for the same per cent of CO_2 it varies directly as the rate of combustion.

The furnace draft depends on many things: (a) the kind of coal; (b) the rate of driving; (c) the thickness of the fire; (d) the condition of the fire; (e) the formation of clinker, etc., from all of which it is evident that the proper regulation of the draft requires close and intelligent observation and judgment.

(6) Skillful firing and intelligent manipulation are therefore prime requisites in the economic operation of steam boilers, and that is why the expert, when he is conducting an efficiency test, is so particular in selecting his firemen. Nor does he rest satisfied with having selected the best available firemen. He knows that even the best of them, using their unaided judgment, cannot be relied upon to manipulate the fires so that maximum economy will result. To overcome the errors due to the inadequacy of judgment, he resorts to the analyzing of the flue gases, which is the only correct and adequate method of controlling the process of combustion.

(7) Flue gas analyses therefore furnish the key to continued high boiler efficiency and in connection with the stack temperature constitute a measure of the heat wasted up the chimney and the lack of such analyses is the principal reason why the high boiler efficiencies practically demonstrated by expert tests are never attained in every-day practice.

Relation of Gas Temperature and CO_2 to Efficiency

Maximum efficiency results when the necessary amount of fuel is completely burned with a minimum excess of air, and the flue gases leave the boiler with the lowest temperature consistent with the rate of driving. Without adequate means of knowing when this condition obtains it is impossible for even the most expert fireman to maintain maximum efficiency.

Combustion experts, when conducting efficiency tests, generally determine the per cent of CO_2, CO and O; but for every-day practice it is necessary only to have the per cent of CO_2 and the temperature of the flue gas to be able to tell whether the boiler is being operated economically or wastefully, and to what extent heat is going to waste up the chimney. The per cent of CO_2 is a correct index to the volume of excess air, and hence to the total weight of the flue gas per pound of coal burned by its specific heat and temperature, i. e., the difference in temperature between the air in the boiler house and the escaping gases, we get the heat wasted up the chimney for every pound of coal burned. An instrument which continuously indicates and records the per cent of CO_2 contained in the gas, as well as the temperature of the escaping flue gas, may therefore without great impropriety be called a waste meter. Such an instrument being now available in a practical and reliable form and at a reasonable cost, there seems no good reason why it should not become an adjunct of every boiler plant where economical operation is striven for.

Excess Air

I have endeavored to make clear that the economical operation of a steam boiler depends on many conditions, most of them variable, yet all of which must be controlled, and if uncontrollable they must be met if maximum efficiency is to be maintained. This cannot be properly accomplished unaided even by an intelligent and experienced fireman conscientiously exercising his best judgment and skill. It is quite impossible for any fireman, no matter how intelligent and experienced, to tell from mere observation whether he is burning his coal with the right amount of air or with 100 or even 200 per cent excess. He may therefore be doubling or trebling the waste of heat up the chimney without being aware of it. Whereas, if he has before him the per cent of CO_2 and the temperature of the escaping gases, there is no more excuse for such waste than there is excuse for great variations in the required steam pressure when he has a steam gage before him. It would be considered preposterous to expect a fireman to maintain a steady steam pressure without a steam gage to guide him, and it is just as preposterous to expect him to operate his fires in the most efficient way without the proper means of knowing where he is at.

Not less than 90 per cent of the avoidable heat losses in the operation of steam boilers are due to excessive air supply, and since the per cent of CO_2 in the flue gas is a correct index of the excess of air it contains, an instrument that will continuously indicate and record this constituent is a most important if not an absolutely necessary factor in attaining and maintaining maximum boiler efficiency.

A continuous record of the temperature of the escaping flue gas, although less valuable as a control of the boiler operation, is nevertheless of great importance. The temperature, when recorded simultaneously with the CO_2, will give most valuable information as to the condition and operation of a boiler. The temperature of the flue gas is but slightly affected by excess of air supplied to the furnace, hence cannot be directly controlled by the fireman. It depends (a) on the ratio of the heating surface of the boiler to the grate area, if the boiler has insufficient heating surface the gases will escape at a high temperature; (b) on the condition of the heating surface, the stack temperature necessarily rises as the boiler becomes dirty, and the temperature record is very valuable in revealing this condition; (c) on the rate of driving, the harder a boiler is driven, the higher the stack temperature, and that is the principal reason why economy suffers when a boiler is driven at an excessive rate; (d) the stack temperature is markedly affected by air infiltration, while an excess of air supplied to the furnace affects the stack temperature but slightly, and that in an upward direction, the air which enters through pores, cracks and crevices of the setting materially reduces the stack temperature. Thus we see that the stack temperature alone may give very misleading information, but in conjunction with CO_2 gives valuable information about the condition of the boiler itself as well as the boiler setting.

Influence and Importance of Draft

A third source of important information relates to the draft conditions, and but little has been done in the way of indicating and recording draft, or more correctly speaking, resistance to draft, in a manner to give valuable practical information useful in regulating combustion, with a view of attaining and maintaining maximum boiler efficiency.

In boiler plants depending on natural draft, one chimney generally serves a number of boilers. A draft gage connected with the chimney or the main smoke flue indicates the total available draft. The draft induced by any given chimney varies (a) with the stack temperature—the higher the temperature the stronger the draft; (b) with the temperature of the outside air—the colder the outside air, the better the draft; (c) with the barometric pressure—the higher the barometer the keener the draft; (d) with the humidity of the air—the greater the per cent of moisture in the air the poorer the draft. All these variations except, perhaps, the fire, depend on conditions beyond control.

There is, however, one other factor which affects the available draft of a chimney to a greater extent than all the influences mentioned above, viz., the per cent of CO_2 in the flue gas. All other conditions remaining the same, the higher the per cent of CO_2 the better the draft. This is due to the fact that the volume of the flue gas varies inversely with the per cent of CO_2, and the greater the volume of gas crowded through a given chimney the poorer will be the draft. Due to wasteful firing, leaks in the boiler setting, poorly fitting breeching, cracks in the smoke flue, etc., the per cent of CO_2 in the stack rarely exceeds 5 per cent whereas, if all air leaks were closed, an average of 10 per cent should be easily attained with fairly economical firing. Raising the per cent of CO_2 in the chimney from 5 to 10 per cent will more than double its capacity. There are a large number of boiler plants where the chimney draft is insufficient solely because the per cent of CO_2 is allowed to fall too low.

There is therefore a definite relation between CO_2 and total available draft as well as boiler efficiency; hence a chimney should be relieved of its illegitimate burden due to low CO_2 before considering other means for augmenting the draft. Instances are by no means rare where expensive chimney construction or costly installations of induced or forced draft could have been saved by keeping the per cent of CO_2 at its maximum.

The total effective draft is what is indicated by nine-tenths of the ordinary draft gages, and if all other conditions remained constant it would be an index to the volume of gas passing through the boiler and, with a perfect setting, to the rate of combustion hence the rate of driving, and would be useful in regulating the steam production.

But since the conditions, especially those of the furnace, upon which the effective draft necessary to maintain a definite rate of driving depends, vary continually, it is evident that the effective draft must also vary, and cannot be a true index to the rate of combustion.

A draft gage applied to the furnace shows the resistance through the ashpit door, the grates, the ashbed, and the fire. With a given effective draft, if the ashpit doors are partially closed the furnace draft is increased, but the rate of combustion is decreased. The same effect is produced by the accumulation of ashes, the formation of clinker, and the caking of the coal. The furnace draft is thus increased by at least 4 distinct causes, all of which tend to check the rate of combustion. On the other hand, if the fire is sliced, the furnace draft is decreased and combustion is increased, and still more is this the case when the fire has been cleaned. It is clear, then, that the readings of a draft gage in the furnace cannot be relied upon as an index to the rate of driving, much less to economical operation.

Relation of Draft to CO_2

From the foregoing somewhat detailed but by no means exhaustive analysis of draft and its relation to combustion it would appear, 1st, that the total available draft, i. e., the chimney draft, is affected favorably by wasteful boiler operation due to a low per cent of CO_2 in the flue gas, but that a knowledge of the chimney draft and temperature are of no great value as a check on economic operation of a boiler plant; 2nd, that the effective draft upon which depends the rate of combustion is itself dependent on the variable conditions of the furnace, that it cannot be relied on as a guide by which to regulate combustion; 3rd, that furnace draft due to the ever changing conditions must necessarily vary if a definite rate of combustion is to be maintained, and is therefore useless as a guide, but is of greatest value as an index to the condition of the furnace, provided we have a true index to the rate of combustion. Fortunately, such an index can be made available.

Boiler draft, as already stated, is the resistance offered to the products of combustion in passing through the boiler, which is measured by the difference between the furnace draft and the effective draft. In any given setting the boiler draft depends on only 2 factors, viz., the rate of combustion and the per cent of CO_2 in the flue gas. For a given per cent of CO_2 the higher the boiler draft the greater the rate of combustion. And for any given rate of combustion the higher the per cent of CO_2 in the flue gas, the boiler draft becomes a true index to the rate of combustion. This is most important, since such an index shows whether each fireman is doing his proper share of work, and whether every boiler is being driven to its proper capacity.

From what has been said in the foregoing, it should appear evident that in order to attain and maintain high boiler efficiency it is necessary to employ scientific means for the purpose of gaining the information necessary to economical operation.

To get at the proper solution of the problem of attaining and maintaining maximum boiler efficiency, it must be realized that combustion is a chemical phenomena, which can be diagnosed and controlled only by chemical means. And it is for this reason that the CO_2 meter, and better still the CO_2 meter in combination with a pyrometer recording the temperature of the escaping gases, which combination may be termed the waste meter, is indispensable if maximum efficiency is to be attained and maintained.

The waste meter holds the same relation to the boiler that the steam engine indicator holds to the engine, with this important difference, viz., that due to the comparatively fixed conditions as to steam pressure, valve motion, speed regulation, etc., an occasional indicator test is all that is required to keep an engine in perfect adjustment; whereas the conditions which influence the operation of the boiler vary continually not only from day to day, but from hour to hour, and from minute to minute, so that the phenomena of combustion must be continuously indicated in order to be properly controlled.

LETTERS DIRECT FROM THE PLANT

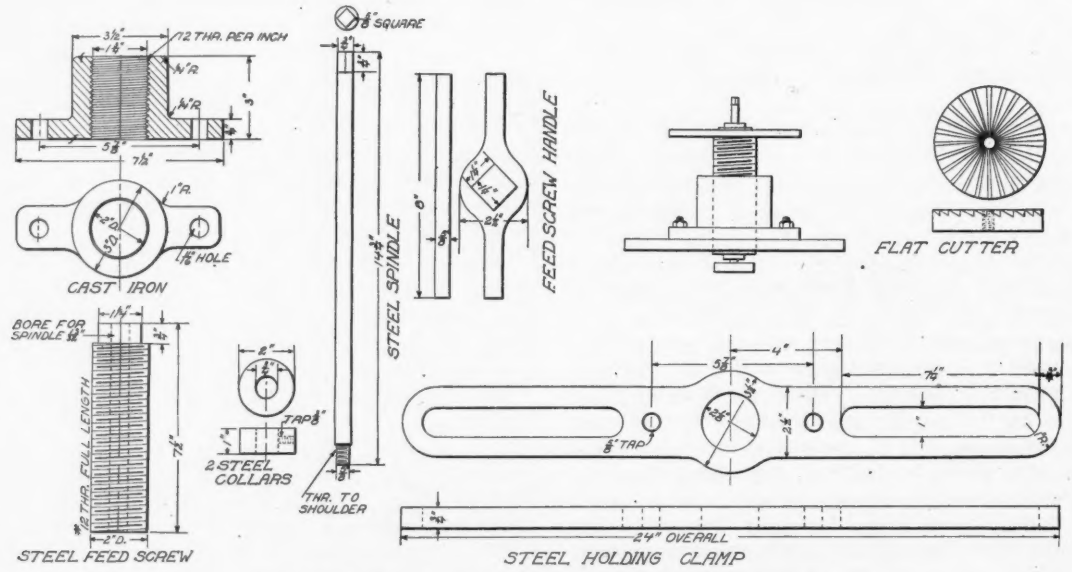
Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Reseating Pump Valves

WHILE IN charge of a manufacturing plant some years ago, the writer had a number of pumps of different types and makes working on high pressure. The seats of all of these pumps had been neglected for some time and were in bad condition. In addition to these pump valves, there were 6 angle blowoff valves on the boilers fitted with brass seats and a babbited disc which was renewed at intervals to reduce the leakage to a minimum. The seats eventually became badly cut and we had no means of reseating them. After looking around for a suitable machine that the company would buy, we decided to make one which would answer the purpose of reseating the pump and blowoff valves, and also any large globe valves about the plant.

top of the discharge valve chamber, a block is placed under each end of the bar, and it is bolted down tight with the studs that hold the discharge chamber cap on.

In making this machine, the only difficulty was to get a good cutter. If means are not at hand for making the cutter, it would be best to purchase it from some company making milling machine supplies. Where hard rubber valves are used, they may be scraped to fit after the seats have been refaced. With brass valves, and especially those having a seat at 45 deg. angle, they should be ground in to a fit with a grinding compound made of No. 1 cup grease, into which has been worked as much powdered glass as it will take without becoming too stiff. This compound will stick to the surface to be ground, and will not run off like oil.



SHOP DRAWING FOR MAKING VALVE RESEATING MACHINE

The accompanying drawing shows the arrangement, details and dimensions of the several parts with the cutter used for flat seats. Some of the pumps had seats on an angle of 45 deg., in which case a cutter of the proper shape was used. The body of the machine was made to fit the studs on the pot-valve type pumps, the bolt holes taking the valve cap studs and also the hinged studs on the blowoff valves. The studs on the extension bar also fit these holes, and it is bolted to this when used on flat valves in the ordinary type of boiler feed pump. When reseating the discharge valves in this type of pump, which are usually level with the

When this machine was used on the blowoff valves occasionally, the steam and water issuing from the open end of the blowoff pipe was kept down to a minimum. Each valve could be reseated several times, and when the seats were worn out they were knocked out and a new one was made and put in.

In most power plants, there are but few globe valves above 4 in., as gate valves are more frequently used except for certain conditions. This machine, with some modifications, can be used for reseating these valves. For reseating globe and angle valves up to 4 in., there is a machine on the market that beats anything that can

be made in the plant, and which will soon pay for itself.

Prior to the advent of our homemade machine, it had been the custom to remove a valve when the seat became badly cut or the stem broken and put on a new one, also when a new lot of valves were purchased, quite frequently they were of a different make and type from any that had been bought before. About this time, we had an accumulation of possibly 200 valves of all kinds and makes, from ¼ in. up to 4 in., that had been discarded to the scrap pile. Some were without wheels, others without discs, some had broken stems, and packing glands missing or the thread stripped. Many of them only needed reseating and a new disc. They were all gathered up and a good "handy man" given the job of fixing up as many as possible. He went over the pile, examined them and made a list of the parts needed, which were ordered from the factory. Those that were past fixing were put in the scrap pile.

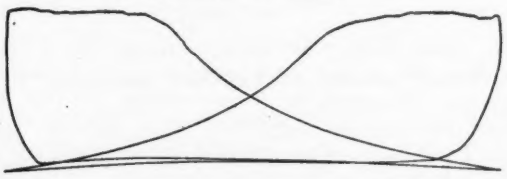
When he had finished repairing them and had tested them with air pressure, we had a stock of valves of all kinds that were in many cases as good as new and could be used for many purposes, especially on low and medium pressures. In some cases, it might not be worth while to go to this trouble of repairing the old valves; but we found that it paid and, for a year or two at least, we reduced the cost of new valves to a marked extent.

J. C. HAWKINS.

Criticism of Ice Machine Card

IN REFERENCE to article on cards from ice machine, which appeared in the March 1 issue, page 260, I offer the following:

Card No. 3, which is the one to which attention is called, shows that the events take place earlier on the left end than they do on the right, therefore I would say that the valve was moved a trifle too far (or the valve stem was lengthened too much).



CARD FROM ICE MACHINE SHOWING GOOD PRACTICE

The events are early enough and I should retard the eccentric a trifle, making the events just a little later. This would decrease the compression and is the only way that it can be done without altering the valve or valve travel, for in altering the valve, what is gained by lack of compression is usually lost, inasmuch as the exhaust opens so much earlier. The valve was no doubt properly designed, but not set right, as the Card No. 1 shows.

Herewith is a card taken from an ice machine of a different make, and I think that the card will meet with the approval of the reader; one end was left showing more work, for the machine is of such nature that more work is required on that stroke than on the return. This card was taken with 252 lb. receiver pressure and exhausting into 79 lb. absolute pressure with the cutoff of valve so that the expansion reaches the exhaust line. The size of cylinder was 7½ by 14, running at 68 r.p.m.

I will further state that the amount of compression I would advise anyone to use is the amount that has proved to cause the least vibration of the engine. This will, of course, vary with the size and revolutions of the machine.

F. C. W.

Valves in Blowoff Line

ON page 308 of the March 15 issue, we note Question 16 and answer is as follows:

"Q. Where is the blowoff pipe connected to boiler, and what kind of valve used?

"A. The regular blowoff pipe should always be connected at the rear bottom end of the shell. It is best to use 2 valves on a blowoff line, one a globe and the other some form of quick-closing valve, a gate or cock."

A globe valve should not be used on the blowoff line. The fact is that some states, as we understand it, prohibit its use on the blowoff line. Even a gate valve is not the best fitting to use for this purpose, as this valve is subject to injury from any gritty substance, and certainly the blowoff line carries a great deal of sediment with it.

The best accepted practice for this purpose among leading engineers and power plant officials is to have 2 valves, one a plug cock and the other an angle valve. This has a double advantage in that it saves an extra fitting from the blowoff valve to the waste pipe.

HOMESTEAD VALVE MANUFACTURING CO.,
SAM'L I. FINK.

Save the Drops

IT HAS often been written that little is known about the amount of lubricating oil that should properly be used in a steam engine. How many drops per minute is the correct number? One or 10?

One drop per minute may not be enough in your engine; 10 may be too many. It is impossible to look inside an engine and actually *see* what the lubricant is doing, and even then we couldn't be sure without a test of some kind.

A good test for determination of the correct amount of lubricant is the "flywheel test."

While feeding, say, 10 drops of oil per minute to the cylinders, just after a long run, and while running at normal speed, throw off all load from the engine. Then suddenly close the steam valve. The flywheels will cause the engine to continue to run for some time, and that is an important factor. How long does it take to stop? By use of your watch you can find the time to the second. Make a note of the time required to stop from the instant the steam valve is closed until the engine stops "dead."

Next time try 9 drops of oil per minute, but do not allow any other condition to be changed. If the stopping time is the same, you may as well save 60 drops an hour, 600 drops a day, or 18,000 drops a year.

Then try 8 drops, 7 drops, 6 drops, etc. Finally, use the least number which permits maximum stopping time.

Judgment must be used with this test, of course. Do not choke down the lubricant until the cylinder is liable to be ruined. But as long as the stopping time is at its highest you can feel pretty sure that the cylinder is well lubricated.

N. G. NEAR.

Installing a Gasket

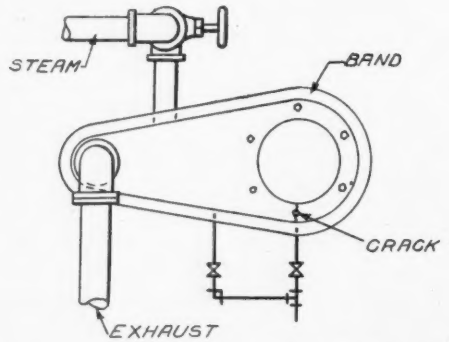
In reference to articles on page 183, Feb. 1 issue, and page 262, March 1 issue, both these articles show novel ways of doing the same job; but the early issue refers only to low-pressure joints, as modern high pressure joints are almost all built up of male and female flanges and under such conditions the flanges must be sprung apart from ½ to 1 in., according to the diameter of the pipe. When the conditions allow the pipe to be opened 1 in. or more, then it is necessary to take out all bolts; but for the convenience of drawing the flanges together again, I use long bolts threaded to near the head to draw the pipe back into place.

Where the pipe will spring apart enough to allow the flange to be cleaned and flanges are heavy enough to allow the setting up on all bolts without springing flanges, then the latter article is good, as the expense of the gasketing material will not be so high.

Usually, one will find that all the bolts must be taken out to free the nuts, as there is some rust causing them to become frozen to the bolts. F. C. W.

Peculiar Engine Accident

While leisurely eating my lunch one night, several years ago, I heard a pounding in one of the units under my care, and before being able to investigate the trouble or even realize that there was any, the lights went out accompanied by the sound of escaping steam. Groping my way in the dark, I found the main valve on the steam header and shut off the escaping steam; then I found a lantern by the light of which I was able to see where I was and what had happened.



BAND ENCIRCLING STEAM CHEST AND CRACKED CYLINDER

My great desire at the moment was to get the service on again, and with lantern in hand, I went over to the other unit, which consisted of an old high-speed automatic engine belted to a generator. To add to my troubles, this machine refused to generate after I had it up to speed; but after replacing some fuses and tightening up loose connections, I had the lights burning again.

At last, I was able to turn my attention to the cause of all this trouble and found the lower bolt on the crankpin box broken, the top bent, the connecting rod bent, the cylinder head knocked off and the piston torn from the rod. Both piston rings were broken and the cylinder was cracked as shown in the sketch.

It was afterward found that the piston rod was held by only ⅛ of its cross-sectional area and it was but a question of time as to when it would have parted.

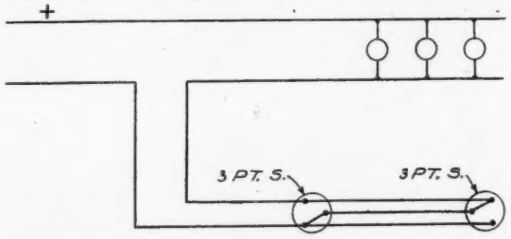
The cause of the trouble was that the lower bolt on the crankpin box broke and then the upper one bent, giving the crankpin box so much lost motion that the piston knocked the cylinder head off and, due to the rod being in the condition it was, that parted from the piston.

To repair the cylinder, a band was made to fit around the steam chest and cylinder (as shown in the sketch), and shrunk on, this keeping the crack closed. New piston rod, rings, and bolts for the crank box were made, and new stud bolts placed on cylinder head. L. K.

There may be some difference of opinion as to the order in which the breaks occurred, and the effect of lost motion in a crankpin box knocking out a cylinder head. What do Practical Engineer readers think?—Editors.

Controlling Lights from 2 Points

Referring to the wiring diagrams on page 235, Feb. 15, there is a rule in the National Electric Code which says that all 3-point switches must be considered as single-pole. I have always considered this rule as prohibiting the connections which are called the "Carter system," as both poles run to each switch.



WIRING FOR 2-POINT LIGHT CONTROL WITH 3-POINT SWITCHES

I know another system of wiring with 2 3-point switches, which has an advantage over the standard way and also over the Carter system, in that either switch can become inoperative or be removed without interfering with the operation of the other switch. This system is wired as shown in the sketch. This system also complies with the National Electric Code, as does the standard system, as only one pole wire touches each switch. Guy G. Logan.

U. S. Civil Service Commission announces an examination, April 25, 1916, for electrical draftsman to fill 2 vacancies in the Bureau of Steam Engineering, Navy Dept., Washington, D. C. at $5.04 a day, and vacancies as they may occur in positions requiring similar qualifications at salaries ranging from $3.52 to $5.04 a day at any navy yard or other naval establishment of the United States or in the Department at Washington. Applicants must have had the equivalent of a high school education and 4 yr. experience, of which 2 have been in marine electrical drafting, or a degree in engineering from a technical school of recognized standing and 1 yr. additional experience in marine electrical drafting. Age, 18 yr. or over. Apply for Form 1312, stating title of the examination for which the form is desired, to the U. S. Civil Service Commission.

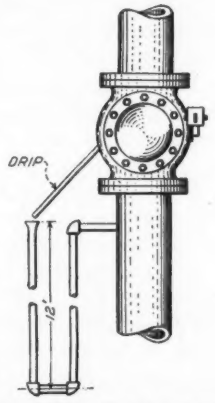
Successful Kinks From The Plant

For Saving Time, Work and Trouble

Back Pressure Alarm

AT THE BEGINNING of our heating season, we experienced considerable trouble because of a defective back pressure valve, one in such bad condition that it would occasionally stick with the valve almost on its seat and thus would allow the steam to back up a considerable pressure unless it was carefully watched. Several times this pressure mounted dangerously high, hence it was decided that some sort of alarm should be installed pending the installation of a new valve.

This alarm feature was obtained by placing a 1-in. pipe water seal or leg connected into the exhaust line just below the back-pressure valve. Since 5 lb. pressure



WATER TRAP USED AS BACK PRESSURE ALARM

was all that would be required, this water seal was made about 12 ft. deep, which, on the basis of 1 lb. equal 2¼ ft. of water, provided for the seal blowing at slightly above the 5 lb. mark and of course, as soon as the water seal would blow, the back pressure valve was forced open by hand and worked loose and reset. While this water seal arrangement was used but one week, until a new valve arrived, it proved to be a good investment because it did away with the constant watching of the valve and also provided a sure alarm.

The drip from the exhaust line above the valve was connected into the water seal to keep it constantly supplied with water. M. SALLER.

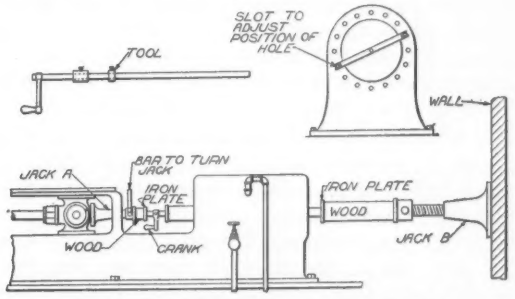
Repairing a Stuffing Box

SOME TIME AGO, the stuffing-box on a 10-ton horizontal double-acting ammonia compressor broke into 3 pieces about 2 in. from the front cylinder head, and we repaired it in this manner:

The 3 pieces were inserted in their original position and held by band clamps and then welded by the acetylene gas process. As some of the molten metal flowed through the cracks and adhered to the bore of the box in such a position that it could not be removed by hand, we had to use a boring bar made as shown in the sketch.

A piece of 1⅛-in. cold rolled steel was cut to a length equal to the length of ammonia cylinder plus 2 ft. The piston rod was removed, together with the piston, and a piece of flat iron secured to 2 cylinder head studs which had a hole in the center which was in line with the hole in the stuffing box, provision being made where the iron was held to the studs to center the hole.

A casting was turned up with an outside diameter equal to the bore of the stuffing-box and held to the cold rolled shaft by 2 countersunk setscrews. Another casting was secured in like manner, containing a cutting tool in its circumference which was adjusted to take the desired depth of cut as the work proceeded.



METHOD OF REPAIRING A STUFFING BOX

A jack was placed against the engine room wall with a piece of joist resting on the cap and a flat piece of iron on the other end on which the steel shaft was to bear. Another jack and piece of wood was placed between the crosshead and the other end of the steel shaft.

The crank from a grindstone was removed and secured to the steel shaft, when all was ready. By turning out on jack A, and in on jack B, the position of the cutting tool could be nicely adjusted in regard to the depth of the box as the work progressed. Turning the crank caused the center to rotate and soon the inside of the box was smooth, ready for the rod and to be packed. The job has run successfully with a head pressure of 190 lb., and shows no signs of distress with the machine working up to capacity. RECEIVER.

To Make Lubricator Glass Fit

RECENTLY THE GLASS in our lubricator broke and the gasket in the top part being useless I had to put in a smaller glass than the packing nut called for. I took a piece of copper wire that would make the difference the glass lacked and cut it so it would fit close to the glass, bringing the ends close together. I took copper because it is more adjustable than iron wire. It is working all right and is standing 80 lb. pressure.

G. M. BROOKS.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Superheated Steam; Reducing Fuel Consumption

How MANY heat units will it take to raise the temperature of superheated steam 1 deg. F.?

2. I have a return tubular boiler 14 ft. long, 3 ft. diameter, with 28 3-in. tubes set in bricks, for heating. I have 8 tenements of 5 rooms each to heat with that boiler, and it is too large for the work. The grate surface is 3 ft. by 4 ft.; I use soft coal.

If I reduce the grate surface to about one-half the amount I now have, put in shaking grates (the grates are stationary now) and use hard coal, will I have good results? As it is now, I burn very nearly 1½ tons of coal a week. The boiler is set about 2 ft. above the grate. H. J. A.

ANSWERS

THE HEAT required to raise superheated steam 1 deg. F. depends on the temperature at which it is superheated, and also the pressure at which the steam exists.

For instance, at 85 lb. pressure, corresponding to a saturated temperature of 316 deg., if raised to a temperature of 392 deg., the specific heat, or heat required to raise the temperature of 1 lb. 1 deg., will be 0.53. To raise the temperature to 572 deg., the specific heat is 0.505. For 142 lb. pressure, the saturated temperature being 350 deg., raised to 392 deg., the specific heat is 0.597; raised to 572 deg., the specific heat is 0.53. For 170 lb. pressure, saturated temperature being 368, when raised to 392 deg., the specific heat is 0.635; raised to 572 deg., the specific heat is 0.541.

No definite answer can, therefore, be given as to the specific heat, unless the pressure at which the steam exists and the temperature of superheat is specified.

2. In regard to your heating problem, we can only make some guesses without full data as to the size of your rooms. We have assumed that this might average 10 by 12 ft., 8 ft. high, giving 960 cu. ft. per room. For 5 rooms there would then be 4800 cu. ft., and for the 8 tenements, this would be 38,400 cu. ft. total. If your radiation is installed 1 sq. ft. to 70 cu. ft., this would give 550 sq. ft. of radiation.

Your boiler would have about 319 sq. ft. of heating surface, or approximately 20 hp. Average good practice gives a horsepower as good for 100 sq. ft. of radiation, or your boiler should be able to take care of 2000 sq. ft. as against the 550 which you may probably have installed.

Another approximate rule is, that 1 sq. ft. of boiler heating surface will take care of 400 cu. ft. of room volume. On this basis, your boiler should take care of 128,000 cu. ft., as against the 38,400 cu. ft. which you may probably have.

On both calculations, the boiler is 3 times as large as necessary.

Burning bituminous coal, it is probable that you are losing somewhat in economy, since you get better efficiency from a boiler with bituminous coal, running at a fairly high rate of combustion, so that the fire is kept at high temperature. It would seem desirable, therefore, to cut down your grate area, whether you continue to use bituminous or anthracite.

Your plan for cutting down ½ the grate area, putting in shaking grates, and using anthracite, will probably work all right. The distance, 2 ft., from the grate to the boiler shell is rather large for a furnace of this capacity to use anthracite coal, since in an anthracite fire a good deal of the heating comes by direct radiation from the fire bed to the boiler shell. This can be overcome to a certain extent by using a thick bed of fuel, if your draft is sufficient to handle it.

So far as your fuel consumption is concerned, Government reports show that in the Federal Buildings, for an 8-month heating season, 5 tons of coal is average per square foot of grate surface. This would give you 60 tons of coal for your 12 sq. ft., for 8 months, or about 7 tons a month, whereas you are burning about 6 tons a month, so that your consumption is not excessive for the size grate that you are handling; but considering the excess of boiler capacity, it would seem that you should be able to get along on 3 tons a month, with the grate properly reduced and the higher rate of combustion per square foot of grate area. A. L. R.

Some Massachusetts Examination Questions

How DOES the water circulate in a 3-drum B. & W. boiler?

2. If you were ordering a new set of piston rings, how would you obtain the proper size?

3. If piston rings were too long, how would you cut them?

4. How would you cool a horizontal return-tubular boiler in the shortest possible time?

5. How would you find the pitch of staybolts in a vertical boiler?

6. Why is the inside strap of a butt-strap joint wider than the outside strap?

7. Are all rivets in a steam boiler in double shear?

8. If you had 2 boilers in battery and their safety valves were set to blow off at 125 lb., and the inspector cut one down to 100 lb., what would you do? Both boilers are connected to a common steam main.

9. Can water from an open heater get into the engine cylinder?

10. How would you find grate area of a vertical boiler?

11. How do you find the horsepower rating of a vertical boiler?

12. How would you know if the governor of a Corliss engine was set right before starting up?

13. How can you tell the difference between a high-pressure and a low-pressure pop safety valve?

14. Your water glass is clear; you try gage cocks and find you have a scant 2 gages of water while glass shows 2½ gages. What is wrong? W. L.

ANSWERS

IN ANSWERING this question, let us start with the feed water which is ordinarily introduced near the front and bottom of the drum or drums. Passing to the rear of the drum or drums, it takes a downward course through the rear circulating tubes to the sections, upward through the tubes of the sections to the front headers and through these headers and front circulating tubes again to the drum, where such water as has not been formed into steam retraces its course.

2. Measure the diameter of the cylinder and have the rings turned, before being cut, about ¼ in. diameter larger than the cylinder, for cylinders up to 20 in.; then have enough cut out of the rings to spring them to the diameter of the cylinder. For larger cylinders, the rings will be cut proportionally larger.

The thickness is commonly made 1/30 of the diameter of the cylinder, plus ⅛ in.; the width may equal the thickness plus ⅛ in. For an eccentric ring, the mean thickness may be the same as for a ring of uniform thickness, with the minimum thickness equal to ⅔ the maximum.

Authorities differ to some extent as to the proper dimensions of piston rings; but the above, given by Kent, may be accepted for all practical purposes. Where you are replacing old rings, we would, of course, advise following the dimensions of these as closely as possible. In such case, the required diameter and thickness will be determined as above, but the width should be the same as that of the old rings. It may also be necessary to take into consideration the width and depth of space provided in the body of the piston to receive the rings.

3. We presume you are here referring to the width being too great. Under such conditions, place the ring in a lathe and remove sufficient stock to give the width desired.

4. To prepare a boiler for cleaning, the fire should be allowed to burn as low as possible and then pulled out of the furnace, the doors being left slightly open and the damper wide open in order that the walls may gradually cool. On account of the injurious effects on the plates and the seams of the shells and the brickwork of the setting, it is just as bad to cool a boiler off suddenly as to fire it up too quickly. After the boiler has become sufficiently cool and no more pressure is indicated by the gage, the blowoff valve may be opened and the water allowed to run out. If operating conditions possibly allow doing so, a boiler should be left for 18 to 36 hr., after being cut off from the line, after which it may be emptied, opened and entered.

5. By direct measurement between centers of adjacent bolts. These measurements may be taken vertically, horizontally or diagonally, representing the vertical, horizontal or diagonal pitch respectively.

6. This form of construction increases the efficiency of the joint, allows the joint to accommodate itself more readily to the curvature of the shell and allows the outer plate to be more easily calked.

7. No. The rivets in double strap butt joints are in double shear; those in lap joints, in single shear.

8. If operating conditions are such that both boilers are run at the same time, the only thing to do under such conditions would be to carry no more than 100 lb. on both units.

9. This may happen by flooding of the heater; but if in working order and properly placed in reference to the engine, trouble from this source ought not to be experienced.

Float valves controlling the flow of water to the heater are provided to prevent flooding.

10. By direct measurement. If the grate is rectangular, the area in square feet is equal to the product of the width, in feet, times the length, in feet; if circular, multiply the square of the diameter, in feet, by 0.7854.

11. Builders of vertical fire-tube boilers allow from 11 to 12 sq. ft. of heating surface per horsepower. Dividing the number of square feet of heating surface by 11, let us say, will give you the horsepower rating.

In order to find the heating surface of vertical fire-tube boilers, multiply the circumference of the fire box (in inches) by its height above the grate; multiply the circumference of a tube by its length and by the number of tubes, and to these 2 products add the area of the lower tube sheet; from this sum subtract the area of all the tubes, and divide by 144; the quotient is the number of square feet of heating surface.

12. First see that the dashpots are hooked up. If there is a safety stop, see that it is in order. The finger on the collar should be in line with the vertical stop.

If there is no safety stop, the pin should be put into its hole in the governor post and left there until the engine is started. This pin keeps the collar from dropping so low that the steam cannot start the engine.

It is also well to see whether the belt driving the governor is in good shape.

13. The size and tension of the spring determine whether a pop safety valve is suitable for low- or high-pressure service.

14. As you know, the water level indicated by the gage cocks is but approximate as compared with that indicated by the glass, and it may be due to this discrepancy that the levels in the 2 appear to be different. Again, due to being in direct contact with the external air, more or less of the steam in the water glass is continually condensing, with the result that the glass may show a water level a trifle higher than that of the boiler or water column. This condensation is, however, slight and hardly of enough consequence to cause any great difference in the indications of the water level.

O. H. H.

Elevator Cables

WHAT 2 materials are most commonly used for elevator cables? READER.

A. Steel and Manila ropes are the 2 most commonly used materials for elevator cables. The Manila rope is generally used for hand-operated elevators, while the steel rope is almost always used in the case of power-operated cars.

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Government Competition in Manufacturing

Is it reasonable to assume that all manufacturers or even a large number of those who supply material for the use of the government of our country are grafters? Is this assumption so far warranted that it is a needful policy for our government to establish large plants to manufacture every line of supplies for which it has use? Where will such a policy lead us?

These questions are prompted by the tendency of Congress to expend huge sums for government owned plants to produce material for whose manufacture adequate private plants are now in existence.

Do the results attained by Federal owned plants now running as compared with costs of operation in similar private plants justify increase of Federal factories?

Is the wise policy to replace private enterprises or to mobilize them for the greatest usefulness, making such arrangements, with a long look toward future needs and possibilities, as will insure reasonable cost of government purchases and the greatest usefulness in emergencies?

This policy ought not to be a matter of politics, of personal prejudice, or of benefit to localities where government plants might be established, but of statesmanship, with, seemingly, a fair assumption that a successful manufacturer is the equal in honesty and patriotism of a successful political officeholder. It is not necessary for the government to deal with men or corporations whose motives or actions are questionable. But what likelihood is there that employes in high or low place in government owned factories will be less actuated by motives of self-interest than men privately engaged?

Record of appropriations by Congress for improvements of waterways and for public buildings do not indicate unusual care or business sense in getting value received for money expended. Are appropriations for government factories likely to be better scrutinized?

Until Congress has proved its ability to manage wisely such enterprises as it now controls, it would seem the part of wisdom to "go slow" in increasing those enterprises. And, if it is in the interest of our country that men be encouraged to make such investment and advance as to enable us to supply all our needs, will a policy of replacing private plants by government monopoly and destroying or injuring existing values help to build up confidence to start those industries now lacking?

These are big questions on which we, as citizens, should make up our minds and then let our wishes be known to our representatives in Washington.

Men

"In the final count it is not the inherent efficiency of plant equipment, nor the cost of supplies, nor the bulk of business that determines the degree of efficiency of the plant or the profit and loss of the enterprise; but it is the *men* who operate the equipment more or less properly, the men who waste or use fuel and supplies efficiently, the men who co-ordinate knowledge and efforts in all stages of the process of power generation, that ultimately achieve or miss the goal."

The above from the pen of Walter N. Polakov expresses a fact that should stick in the mind of every man in the plant. Now read it again.

News Notes

AMERICAN ASSOCIATION OF ENGINEERS, whose offices are at 29 S. La Salle St., Chicago, is an organization for the co-operative promotion of the welfare of its members, started in September, 1915. At present it has 400 certified members, with 150 applications which are being transferred to the certified class as fast as their qualifications can be verified.

One feature of the organization is the service clearing house to fill positions referred to the Association by employers. A summary of activities in this line from March 1 to March 25, 1916, shows 92 applications received for members; 50 positions reported open; 32 members applying for positions; 6 non-members applying; 15 positions filled and 30 positions on the list unfilled. The unfilled positions range from $1200 to $5000 per year, some of them having been open for some time, because of the small number of the applications on file for positions. The Association endeavors to discourage members from changing positions unless they are obviously underpaid or are better fitted for other work than that on which they are engaged.

PLANS ARE RAPIDLY being completed for the next annual convention of the National Gas Engine Association to be held at the Sherman Hotel, Chicago, June 27 to 29. With the rapidly rising and fluctuating prices of materials, the problem of keeping cost of products within bounds is important to all manufacturers of engines and accessories, and the matter of scientific cost accounting is, therefore, of unusual importance. One session of the convention will be devoted to this subject, under the chairmanship of the Cost Accounting Committee, C. B. Segner, and problems of sales managers will be discussed in a similar meeting in charge of O. C. Parker, chairman.

At the third session, Tractors and Tractor Engines will be discussed, taking up papers on Tractor Engines, Carburetion, Traction, and Tractor Equipment, all by recognized authorities, followed by a general discussion. There will be papers on the Design of Oil Engines, by Prof. Norris of Wisconsin University, and by others on marine engines and shop costs.

During the past year, data sheets of various sorts have been compiled and issued, occupying a large amount of the time of Secretary H. R. Brate, who has been assisted by members of the Data Committee, of which P. S. Rose is chairman. About 150 sheets have been issued up to the present time, and when completed, the set will give information on practically all lines of machinery ordinarily operated by internal-combustion engines. Sheets on electric lighting systems for farms have been issued, and will be followed shortly by sets on air compressors, cotton gins, marine engines, hoists, concrete mixers and tractors. On account of the large use of gasoline and oil engines for driving farm machinery, it is likely that sheets will also be gotten out giving data on various makes of such engines, for the use of salesmen and dealers in apparatus such as ensilage cutters, corn shellers, etc., to enable these dealers to determine the size pulleys, speed and size of engine required for various makes. All sheets go with a membership of any grade, and can be secured for as low as $5, the cost of an associate membership.

Final meeting of the Standards Committee before the June convention was held in Parlor O at the Sherman Hotel, March 25, and was open for discussion of matters in connection with the several proposed standards, particularly those for tractors.

W. E. Blair, general manager of the Buffalo Gasoline Motor Co., Buffalo, N. Y., has been elected a vice-president of the association.

IOWA ENGINEERS will hold a state convention at Waterloo, Ia., May 17 to 19, and, at the same time, will hold an exhibit of steam apparatus and supplies.

THE STATIONARY ENGINEERS of New Jersey Association No. 1 of Jersey City, are placing before the engineers of the country John J. Calahan as candidate for the office of National Vice-President, to be elected at the next national convention, to be held at Minneapolis, Minn., in September.

Mr. Calahan has been active in the interests of the national, state and local associations of engineers for many years, and to him is due much of the credit for the success of the state conventions in New Jersey, and for the securing of the license law in that state. He is now supervising engineer for the Department of Education of Jersey City, and his work in that office shows that he has good executive ability, accurate technical knowledge, and a fine business training.

PREPARATIONS ARE UNDER WAY for America's Electrical Week, which is the name selected by the Executive Committee for the celebration from Dec. 2 to 9, 1916. The success of Electrical Prosperity Week of 1915 has been embodied in an attractive 52-page book, entitled "The Story of the Week," which will be of value as a guide to local committees and dealers.

Further information can be secured from the Society for Electrical Development, 29 W. 39th St., New York

IN SOME INTERESTING statistical monographs, Charles Meigs Ripley of New York gives a list of plants in the Metropolitan district, 84 in number, that formerly purchased most of their light and power, but are now served by private plants. The assessed valuation of the group is over $100,000,000. He also shows that of the 31 buildings over 20 stories high, 8 only use street current; of 58 hotels, only 7 use street current; and of 46 railway passenger stations, only 6 use electricity from the street mains. All the rest in each class are supplied from private plants.

J. D. CUDNEY, who for some time has been associated with the Alberger Gas Engine Co. and its subsidiary companies, the Alberger Heater Co. and Howard Iron Works, as sales manager, has recently left their employ and accepted the position of sales manager of the Rathbun-Jones Engineering Co., Toledo, Ohio, builders of the Rathbun Gas Engine.

THREE INDUSTRIAL motion picture films, showing the course, from ore to finished product, in the manufacture of "NATIONAL" pipe, were shown before the American Society of Marine Draftsmen, in the Arcade Auditorium, 14th & Park Road, Washington, D. C., Friday, evening, April 7.

THE RIC-WIL Underground Pipe Covering Co., manufacturers of Ric-wiL underground conduit, of Cleveland, Ohio, has changed its corporate name to the Ric-wiL Co. The organization and location will remain the same as heretofore.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

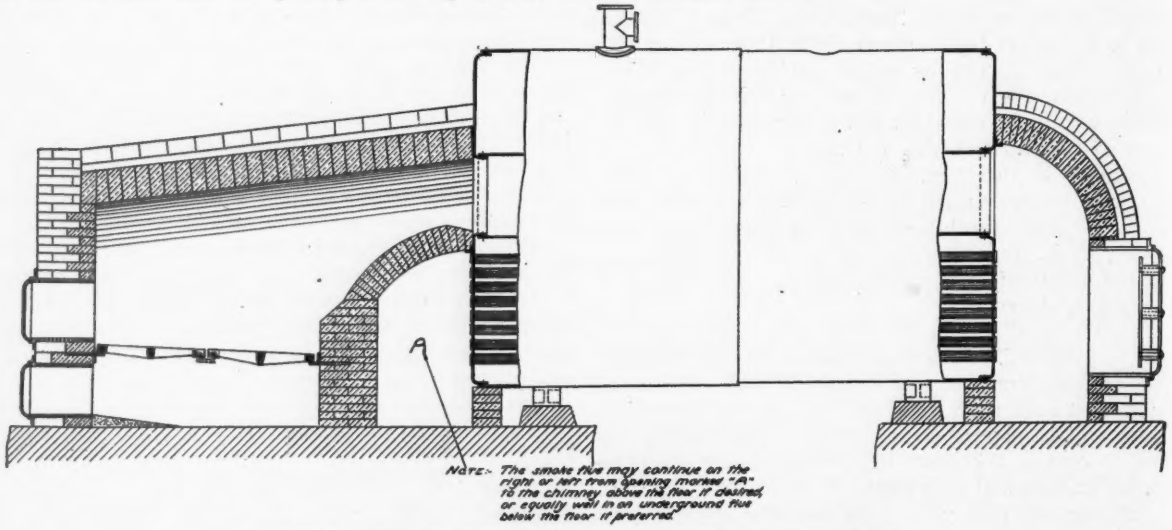
The Compound Lancashire Boiler

IN the compound Lancashire boiler recently brought out by the Kingsford Foundry & Machine Works, Oswego, N. Y., the heating surfaces are so arranged that the hottest flues are in contact with the hottest water in the boiler, as it would naturally circulate. This gives to the gases a travel practically the reverse of that commonly employed, but the advantages are apparent to anybody who has studied the principles of transmission of heat from gases to water through metal partitions.

By examination of the sectional view shown here, it will be seen that the principal heating surface is near the surface of the water; this is of advantage because of the fact that most of the steam generated in any boiler having 2 horizontal passes for the gases is produced by the heating surface nearest to the grate over which the flames and hot gases make the first passage. With the boiler shown here, the steam formed around the principal heating surfaces passes freely and quickly to the surface of the water and is quickly liberated, which action accelerates the circulation in the boiler.

In operation, the flame and hot gases pass from the furnace into the main flues, where a large portion of the heat is given up and where it will do the most good against the principal heating surface near the surface of the water; afterwards the hot gases pass into the return tubes underneath and bring the body of the water in the bottom of the boiler to the boiling temperature, causing it to expand and ascend as the temperature increases, passing upward and into contact with the hotter main flues through which the hottest gases of the furnace are passing. The circulation is thus naturally upward around the heating surfaces which increase in temperature on both the water and gas sides from the bottom of the boiler to the surface of the water.

Brickwork for the setting of this boiler is confined to the furnace and back arch and leaves the boiler proper free from all brickwork so that the plates under tension are always accessible for inspection, and no part that is subject to tension is subject to the direct heat of the furnace. The dutch oven type of furnace is used and is suitably designed for burning bituminous coal without smoke.


A
NOTE:- The smoke flue may continue on the right or left from opening marked "A" to the chimney above the floor if desired, or equally well in an underground flue below the floor if preferred.

SECTIONAL VIEW OF SETTING OF COMPOUND LANCASHIRE BOILER

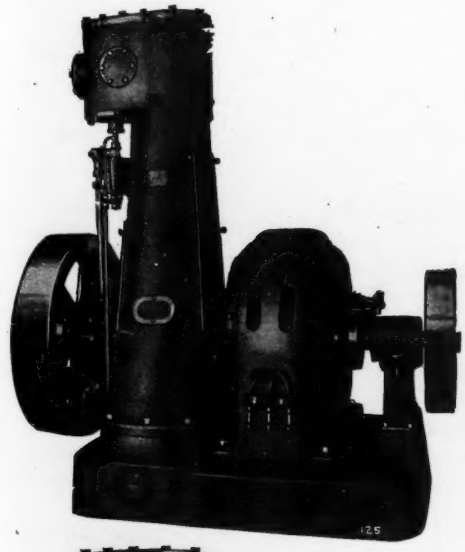
THE SOCIETY OF AUTOMOBILE ENGINEERS, in the effort to do away with confusion in the matter of tire sizes, which had become almost intolerable, has finally adopted the following list, containing 9 standard sizes and 9 over-size profiles, as follows:

Standard	Oversize
30 by 3	31 by 3½
30 by 3½	31 by 4
32 by 3½	33 by 4
32 by 4	33 by 4½
34 by 4	35 by 4½
34 by 4½	35 by 5
36 by 4½	37 by 5
36 by 5	37 by 5½
38 by 5½	39 by 6

This list comes close to fitting all present day demands, and will greatly simplify the matter of tires for manufacturer, seller and buyer.

Compact Generator Set

FREEDOM from complications, with accessibility and ease of adjustment of all working parts are convenient features of the Engberg engine and generator sets which are direct-connected and specially designed for such connection. Removable side doors are provided on each side of the engine frame, allowing access to the crosshead, wristpin, and all adjacent parts, while the handhole plates on the opposite side of the engine frame give access to the lower end of the connecting rod.



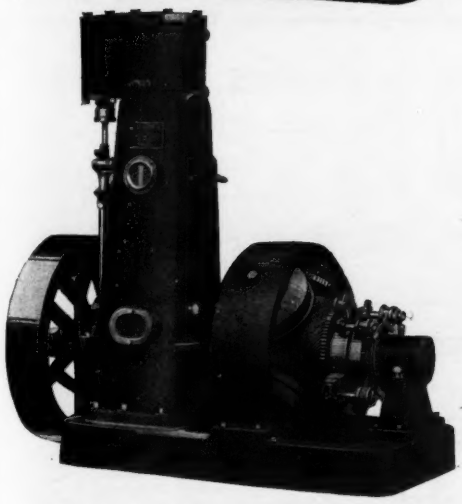


FIG. 1. DIRECT-CONNECTED A.C. GENERATOR SET

FIG. 3. ENGBERG GENERATOR SET FOR DIRECT CURRENT

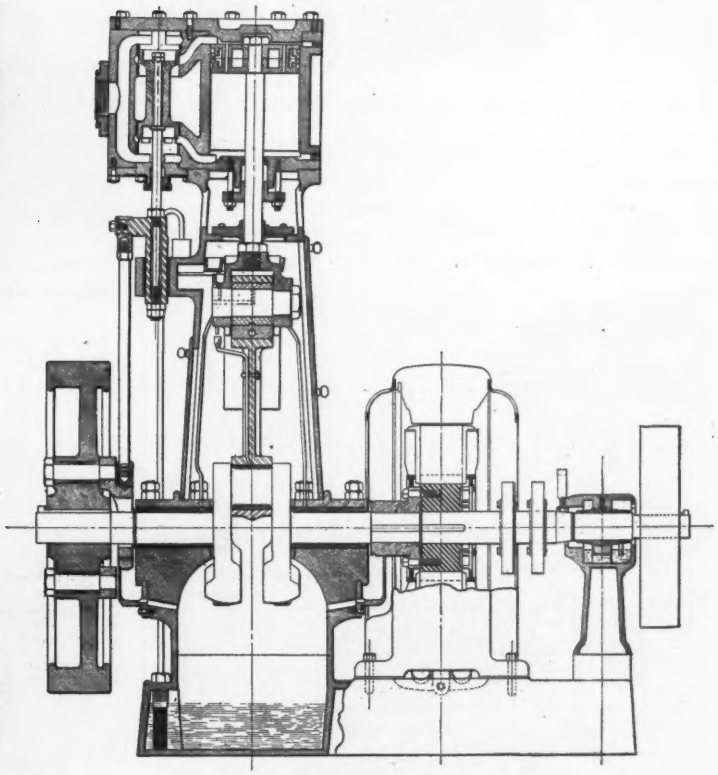


FIG. 2. SECTIONAL VIEW OF A.C. SET

The piston is cast hollow for lightness and pressed on the piston rod, with nut on top and riveted on. The crosshead is fitted with a phosphor-bronze shoe, having a wedge adjustment by means of a bolt and lock nut. A taper fit of the crosshead pin allows it to be easily removed for inspection.

The lower end of the connecting rod has a wide bearing and the upper end is fitted with bronze boxes and provided with standard wedge adjustment. Counter balances are fitted on the crank shaft, and the babbited bushings in the main bearings can be renewed without removing the shaft.

Simple and effective control of the speed is obtained with an inertia weight spring governor which is located on the flywheel, with means provided for changing the tension of the governor springs, when it is desired to change the speed of the engine. Situated in the base of the engine is an oil pump to force the oil from a reservoir up to a sight-feed oil cup, which leads to a distributing trough on the inside of the engine frame. From here oil pipes lead to all movable bearings; then the oil is redrained back to the base, refiltered and repumped. A water-shed partition is provided in the engine frame to prevent the oil from carbonizing by coming in contact with the hot cylinder.

Owing to a well-proportioned design, the generators are capable of withstanding large temporary overload without injury. Standard voltages of 240, 480, 600, 1200 and 2400 are supplied with the a.c. generators. The d.c. type has a compound winding for 115 v., is of multipole design, and has its commutator built up on a separate sleeve and bolted to the armature drum, so that the shaft can be removed without disturbing the windings. The coupling of the engine crank is coupled direct to the armature drum.

These generator sets are manufactured by Engberg's Electric & Mechanical Works, St. Joseph, Mich.

Allis-Chalmers Centrifugal Pumps

IMPROVEMENTS have been made in the design of Allis-Chalmers centrifugal pumps, particularly of the smaller sizes, which have made possible higher efficiencies. In a recent test a 10-in. single stage pump developed an efficiency of 85 per cent, and it is claimed that in larger sizes the same type of pump has given efficiencies as high as 87 per cent.

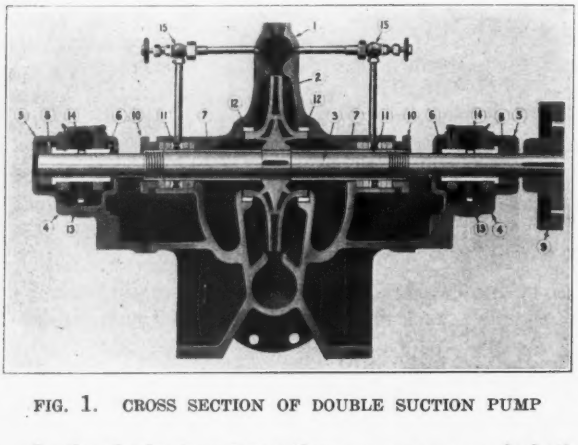


FIG. 1. CROSS SECTION OF DOUBLE SUCTION PUMP

In the single-stage types these pumps are made both single and double suction. The latter, known as Type S, has the casing and bearing housing divided along the horizontal plane of the shaft so as to allow the pump to be easily dismantled for inspection, renewal of wearing ring and repairs. This is further facilitated by locating the suction and discharge nozzles in the lower half casing which allows the top part to be removed without breaking any pipe connections.

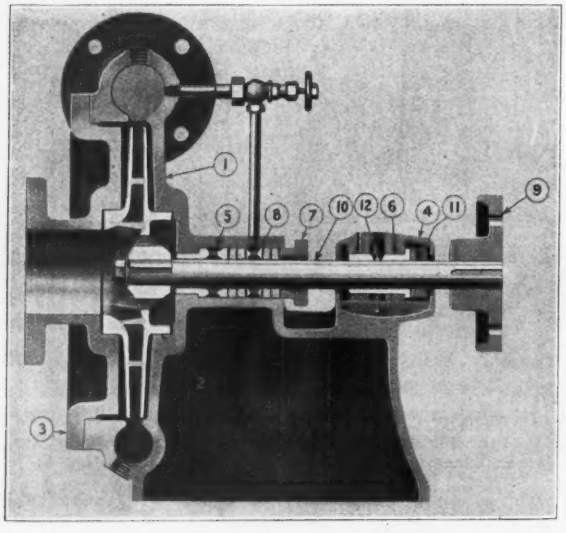


FIG. 2. ALLIS-CHALMERS SINGLE SUCTION CENTRIFUGAL PUMP

The double suction runner is of bronze and is balanced both hydraulically and mechanically; and the shaft which is of open hearth steel machined all over is protected from the action of the water by long renewable brass sleeves. The bearings are of the ring oiling type, independent of the stuffing boxes but attached to brackets cast integral with the lower part of the casing.

Single suction pumps are built in smaller sizes and are known as Type S. S. In these the runner is a single bronze casting and is of the enclosed type arranged so that it is hydraulically balanced. There are 2 bearings, the main bearing being of the removable shell type, and the runner bearing, which is a bronze bushing, placed close to the runner hub. The latter is lubricated by a compression grease cup which supplies grease lubrication to the bearing.

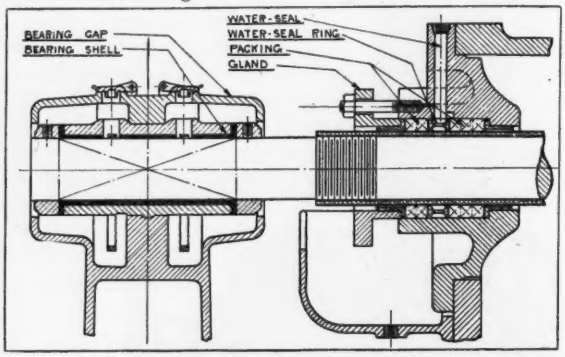


FIG. 3. CROSS SECTION OF STUFFING BOX AND BEARING

Water sealed stuffing boxes are employed in both types which prevent the inleakage of air to the suction side of the pumps. A cross section of the stuffing box and waterseal ring is shown in Fig. 3.

When used for high heads, the multistage arrangement of impellers is resorted to. The impellers are of the single suction type, but end thrust is taken care of by a balancing device. The unbalanced thrust is towards the suction end of the pump and is balanced by a counter pressure in the opposite direction automatically maintained in the proper proportion against the balancing disk. The balancing disk, 4 (Fig. 4), is fixed against a shoulder on the shaft back of the last stage

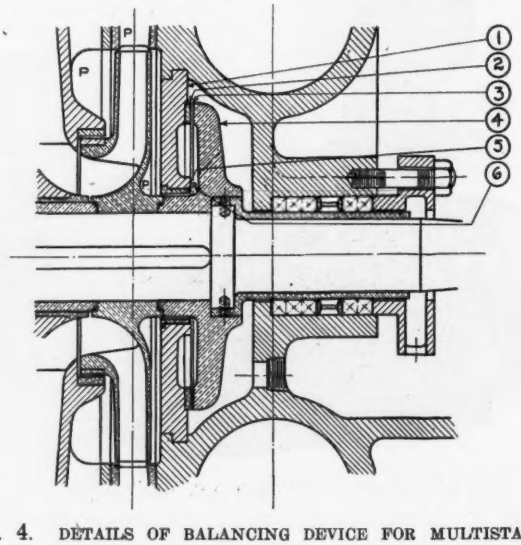


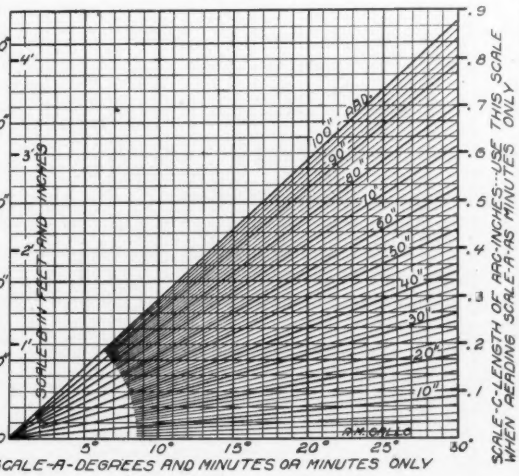
FIG. 4. DETAILS OF BALANCING DEVICE FOR MULTISTAGE PUMPS

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which these tables fit exactly will be sent you for 20 cents

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which these tables fit exactly, will be sent you for 30 cents in currency or stamps.

PRACTICAL ENGINEER

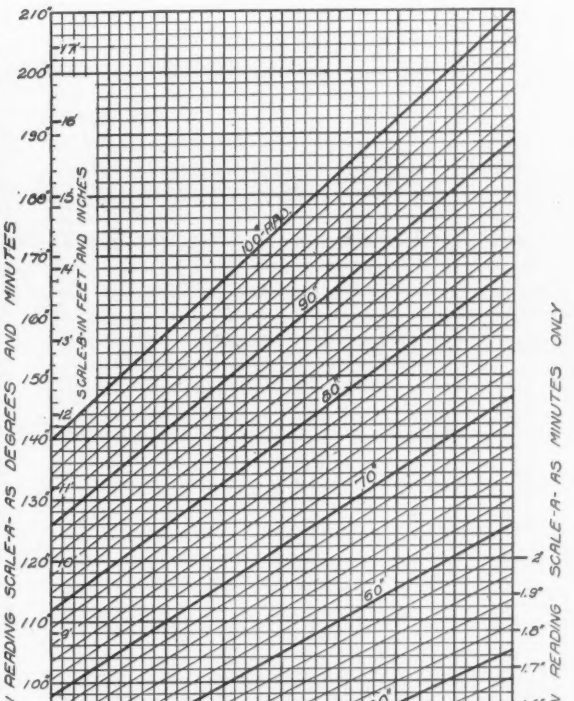
DIAGRAM GIVING LENGTHS OF PIPE SUBTENDING ANGLES
SECTION 1


SCALE-B-LENGTH OF ARC-INCHES---USE THIS SCALE WHEN READING SCALE-A-AS DEGREES AND MINUTES
SCALE-B-IN FEET AND INCHES
SCALE-C-LENGTH OF ARC-INCHES---USE THIS SCALE WHEN READING SCALE-A-AS MINUTES ONLY
SCALE-A-DEGREES AND MINUTES OR MINUTES ONLY
AMONTE

Explanation: These diagrams cover the majority of cases reading direct. For angles of less than 10 deg., divide scale A and B by 10. For angles greater than 100 deg., multiply scales A and B by 10, or find the lengths for proportionate arcs and add them. For example: Length of arc in 135 deg. equals sum of arcs for 100 deg. and 35 deg. Multiplying scale A and radii simultaneously by 10, multiplies scale B by 100. Ex.: Given Rad. = 100 in., Angle = 90 deg. Find length of arc. From 90 deg. on scale A vertically to 100 in. diagonal, horizontally to scale B and read 157.1 in. or 13 ft. 1.1 in. Ex.: Given Rad. = 100 in., Angle = 45 min. Find length of arc. From 45 on scale A vertically to 100 on diagonal horizontally to scale C and read 1.309 in.

PRACTICAL ENGINEER

DIAGRAM GIVING LENGTHS OF PIPE SUBTENDING ANGLES
SECTION 3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SCALE-A-DEGREES AND MINUTES OR MINUTES ONLY
AMONTE

PRACTICAL ENGINEER

EFFICIENCIES AND SAVINGS OF VARIOUS THICKNESSES OF 85 PER CENT MAGNESIA COVERING—M'MILLAN

Temperature Difference	Thickness	B.t.u./Sq.ft./deg.dif./hr. Bare Pipe	Plastic 85 per cent Magnesia	Sectional 85 per cent Magnesia	Saving	Efficiency	Total Saving/yr. B.t.u.	Dollars (Steam at 30c/1000 lb.)	First Cost of Covering	Cost of Covering/yr.	Net Saving
100	0.5	2.162	0.735	0.691	1.471	67.8	1,290,000	0.384	0.125	0.018	0.366
100	1.0		0.492	0.462	1.670	78.4	1,481,000	0.444	0.238	0.033	0.411
100	2.0		0.319	0.300	1.862	85.5	1,622,000	0.486	0.341	0.048	0.438
100	3.0		0.248	0.233	1.919	89.1	1,681,000	0.504	0.438	0.074	0.430
100	4.0		0.209	0.196	1.956	90.8	1,714,000	0.514	0.551	0.110	0.305
100	5.0		0.188	0.174	1.978	91.9	1,739,000	0.520	0.170	0.350	
300	0.5	3.200	0.806	0.767	2.503	76.8	6,579,000	1.975	0.125	0.018	1.957
300	1.0		0.524	0.493	2.767	84.9	7,270,000	2.181	0.238	0.033	2.148
300	2.0		0.335	0.315	2.945	90.4	7,740,000	2.322	0.341	0.048	2.274
300	3.0		0.260	0.244	3.016	92.5	7,922,000	2.377	0.438	0.074	2.303
300	4.0		0.219	0.206	3.064	93.7	8,026,000	2.408	0.551	0.110	2.299
300	5.0		0.192	0.181	3.079	94.4	8,080,000	2.427	1.215	0.170	2.257
500	0.5	5.180	0.896	0.842	4.338	83.7	19,000,000	5.700	0.125	0.018	5.682
500	1.0		0.557	0.524	4.656	89.9	20,410,000	6.125	0.238	0.033	6.092
500	2.0		0.350	0.329	4.851	93.6	21,280,000	6.380	0.341	0.048	6.332
500	3.0		0.273	0.257	4.923	95.0	21,570,000	6.470	0.438	0.074	6.396
500	4.0		0.229	0.215	4.965	95.8	21,750,000	6.525	0.551	0.110	6.406
500	5.0		0.199	0.187	4.983	96.4	21,880,000	6.564	1.215	0.170	6.300

DIAGRAM FOR CALCULATING OFFSET PIPE BENDS

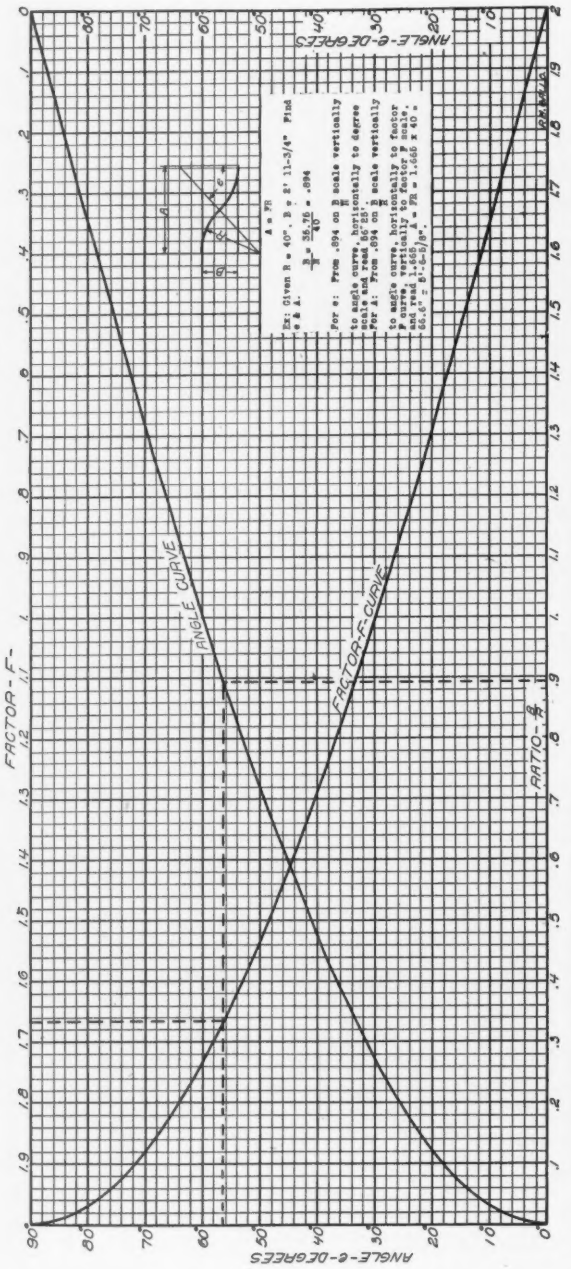
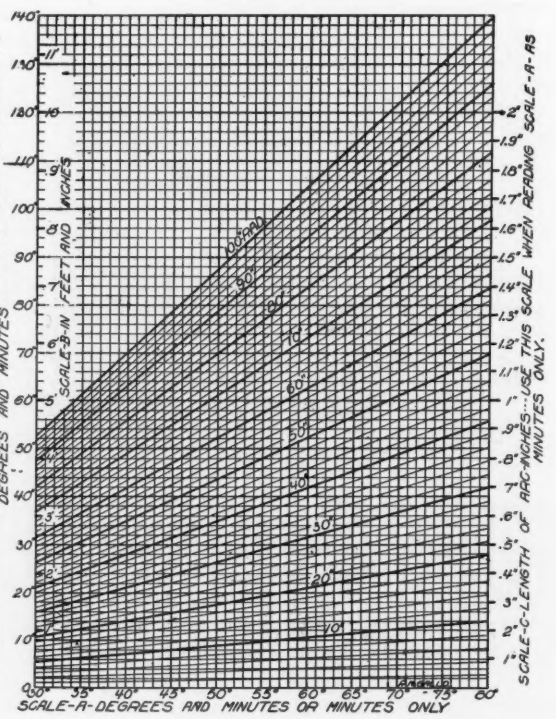

ANGLE-θ-DEGREES
FACTOR-F-
ANGLE CURVE
FACTOR-F-CURVE
RATIO-R
ANGLE-θ-DEGREES
A = FR
Ex: Given R = 40", θ = 22° 11-3/4" Find e & A.
e = 35.75 x .694 = 40"
A = 40" x 1.665 = 66.6" = 5'-6-5/8".
For e: From .694 on R scale vertically to angle curve, horizontally to degree scale and read 35.75".
For A: From .694 on R scale vertically to angle curve, horizontally to factor F curve, vertically to F scale and read 1.665. A = FR = 1.665 x 40" = 66.6" = 5'-6-5/8".

DIAGRAM GIVING LENGTHS OF PIPE SUBTENDING ANGLES
SECTION 2


SCALE-B- LENGTH OF ARC-INCHES--USE THIS SCALE WHEN READING SCALE-A-AS DEGREES AND MINUTES
SCALE-B-IN FEET AND INCHES
SCALE-A-DEGREES AND MINUTES OR MINUTES ONLY
SCALE-C-LENGTH OF ARC-INCHES--USE THIS SCALE WHEN READING SCALE-A-AS MINUTES ONLY.

NET SAVINGS AT VARIOUS THICKNESSES OF 85 PER CENT MAGNESIA COVERING FOR STEAM AT $0.10 AND $0.20 PER 1000 LB.—M'MILLAN

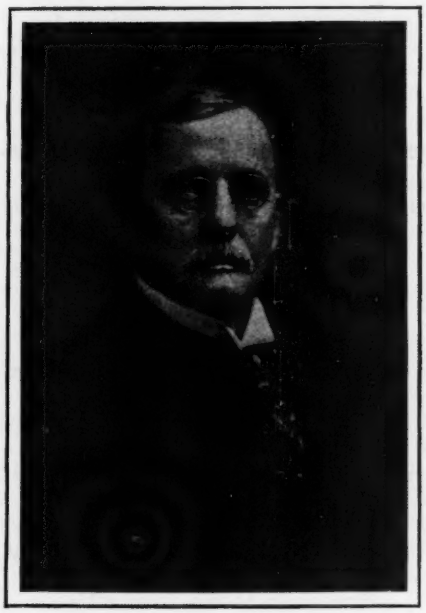
Temperature Difference	Thickness	Total Saving in $ (Steam at 10c./1000 lb.)	First Cost of Covering	Cost of Covering/yr.	Net Saving $/yr.	Temperature Difference	Thickness	Total Saving in $ (Steam at 20c./1000 lb.)	First Cost of Covering	Cost of Covering/yr.	Net Saving $/yr.
100	0.5	0.128	0.125	0.018	0.110	200	0.5	0.256	0.125	0.018	0.238
100	1.0	0.148	0.238	0.033	0.115	200	1.0	0.296	0.238	0.033	0.263
100	2.0	0.162	0.341	0.048	0.114	200	2.0	0.324	0.341	0.048	0.276
100	3.0	0.168	0.528	0.074	0.094	200	3.0	0.336	0.528	0.074	0.262
100	4.0	0.171	0.851	0.119	0.052	200	4.0	0.342	0.851	0.119	0.223
100	5.0	0.173	1.215	0.170	0.003	200	5.0	0.346	1.215	0.170	0.176
200	0.5	0.658	0.125	0.018	0.640	300	0.5	1.316	0.125	0.018	1.298
200	1.0	0.727	0.238	0.033	0.694	300	1.0	1.454	0.238	0.033	1.421
200	2.0	0.774	0.341	0.048	0.726	300	2.0	1.548	0.341	0.048	1.500
200	3.0	0.792	0.528	0.074	0.718	300	3.0	1.584	0.528	0.074	1.510
200	4.0	0.803	0.851	0.119	0.684	300	4.0	1.606	0.851	0.119	1.487
200	5.0	0.809	1.215	0.170	0.639	300	5.0	1.618	1.215	0.170	1.448
300	0.5	1.900	0.125	0.018	1.882	400	0.5	3.800	0.125	0.018	3.782
300	1.0	2.040	0.238	0.03	2.007	400	1.0	4.080	0.238	0.033	4.047
300	2.0	2.126	0.341	0.048	2.078	400	2.0	4.252	0.341	0.048	4.204
300	3.0	2.157	0.528	0.074	2.083	400	3.0	4.314	0.528	0.074	4.240
300	4.0	2.175	0.851	0.119	2.056	400	4.0	4.350	0.851	0.119	4.231
300	5.0	2.188	1.215	0.170	2.018	400	5.0	4.376	1.215	0.170	4.206

impeller and the face of the disk rotates normally close to the seat, 2, with a film of water in the clearance space, 3, separating the disk and seat. The hub of the balancing disk extends through the thrust plate 1, which is a stationary desk held in the casing leaving an annular opening, 5, between the hub of the balancing disk and the thrust plate.

All of these pumps are built especially for direct connection to electric motors, but are also suitable for any other type of drive.

John C. Hooven

MR. HOOVEN, or since 1895, when he organized the Hamilton Rifles and was made their commanding officer, Colonel Hooven, died at his home in Hamilton, O., Mar. 1. Born in Ohio in 1843 and educated in the schools of Franklin, he entered the hardware business with his father in 1864 at Xenia as Hooven & Son, and 10 yr. later removed to Hamilton, where the firm, changed to Hooven & Sons, engaged in agricultural implement manufacture, producing Monarch portable engines, threshers and sawmills. In 1878, John C. Hooven became sole owner and expanded the business



so that in 1880 the present firm of Hooven, Owens, Rentschler Co. was organized to handle the work, entering also the field of Corliss engine building with the Hamilton-Corliss engine. Colonel Hooven became president, and served in that capacity until his death.

Twenty years growth brought a need for doubling the capacity of the plant in 1900, and the Company began its specialization in extremely large work, such as the big engines for the St. Louis Fair, the gas-steam engines for the Ford motor plant at Detroit, and sugar mills for the South and Cuba, for which it has since been noted.

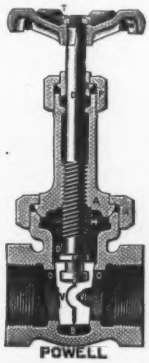
Besides his interest in civic matters, Colonel Hooven was a large factor in many business enterprises, as president of the Republican Publishing Co., organizer of the traction line to College Hill, and of the Cincinnati, Lawrenceburg & Aurora Traction Co., vice-president of the American Frog and Switch Co., and organizer of the Dayton Rubber Co., the Cincinnati Horseshoe Co., and the firm of Craighton & Hooven.

He served his country through the Civil War with the 146th Ohio Infantry, and always retained his interest in proper preparation for defense, as shown by his work with the Hamilton Rifles.

Mrs. Hooven and five children survive, the four sons being connected with the Hooven, Owens, Rentschler Co.; C. E. Hooven as treasurer and manager, Paul Hooven as representative in the Boston district; Enyeart Hooven as Chicago agent, and Don Hooven as purchasing agent.

Catalog Notes

POWELL WHITE STAR Gate Valves with rising and nonrising stems, and having double-disc gates designed to take pressure either way, are described in the gate valve booklet recently issued by The Wm. Powell Co., Cincinnati, Ohio. All styles are shown, in 2 to 12-in. with iron body and bronze trimming, and in sizes from



½ to 4½-in. with bronze bodies. Construction is shown, which embodies the results of years of experience, in the sectional view herewith. The booklet, containing complete data and illustrations, will be sent on request by The Wm. Powell Co. to any engineer, superintendent or purchasing agent.

WATERPROOF GRAPHITE GREASE is the title of a new 16-page booklet gotten out by the Joseph Dixon Crucible Co., Jersey City, N. J. This book explains fully, in a concise and clear way, how many difficult lubricating problems have been overcome. It also deals with the care and up-keep of heavy, slow-moving machinery and parts that are exposed to unusual wear. Some of the subjects treated are lubrication of elevator plungers, the best way to handle wire rope, open gearing, dredging machinery, and rolling mill lubrication, the lubrication of sugar rolls, pulp and paper machinery. A copy of this booklet will be sent to anyone who is interested.

BULLETIN 46,023, recently issued by the General Electric Co., describes briefly that company's Arc Circuit Volt Meter, which is a special instrument designed for testing direct-current series arc circuits. The approximate dimensions and the connections together with prices are included.

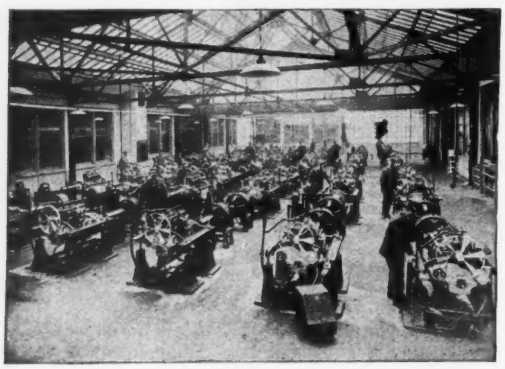
COMMUTATING POLE Rotary Converters are carefully described and well illustrated in leaflet 3823-A just issued by the Westinghouse Electric & Mfg. Co., which states that 1¾ million kilowatts of Westinghouse rotary-converter capacity is in operation under widely varying conditions.

The design of rotary converters has changed considerably in the last several years and this leaflet points out where the newer designs are more effective than those of earlier date.

BOOK NO. 238, describing two standard types of Link Belt grab buckets, has just been received from Link Belt Co., Chicago, Ill.

Trade Notes

THE PACKARD Motor Car Co., of Detroit, plans and strives continually to attain to that measure of quality of which it is justly proud. The Packard standard is upheld by skill in designing, selection of materials, and care in manufacturing. But to further insure a perfect running car, every engine is carefully tested before being installed in its car. In the illustration, 40 of these engines in the large Packard test room are shown; 40 Westinghouse 15-hp., direct-current electric motors are shown driving these engines, so as to grind in



all the bearings and wearing parts. When the engines operate smoothly and with the minimum amount of friction demanded by the Packard standard, it is shown on the ammeter used in connection with each electric motor. As the engine runs easier, the current decreases until the point is reached where the highly desired smoothness of action of the Packard is obtained. Every Packard engine goes through this test room for its rigid test for reliability, smoothness of action, etc.

INCREASED DEMAND for the apparatus made by the Engberg's Electric & Mechanical Works, of St. Joseph, Mich., has made it advisable for them to open branch offices as follows: New York office, 39 Cortland St., D. J. Rowland, Mgr.; Chicago office, Fisher Bldg., Frank H. Pond, Mgr.; Milwaukee office, Wells Bldg., Fred H. Dorner, Mgr.

WALTER CASTANEDO, for many years New Orleans representative of the Harrisburg Foundry & Machine Works, has been appointed district manager for Ames Iron Works, Oswego, N. Y., at New Orleans, with headquarters at 1101 Hennen Building.

PRACTICAL ENGINEER

Trade-mark, Reg. U. S. Pat. Off.

PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH.

SEMI-MONTHLY

Subscription price in advance in the United States, Mexico or united possessions, $1.00 a year.

In Canada, subscription price, $1.75 a year.

Foreign Countries, subscription price, $2.50 a year.

Address all letters and make all checks and money orders payable to Technical Publishing Co., 537 So. Dearborn St., Chicago, Ill.

Any advertiser is invited to examine our paid subscription lists and Post Office mailing receipts at any time.

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Full page, one year, each insertion, $60.00.

Half page, one year, each insertion, $35.00.

Quarter page, one year, each insertion, $20.00.

Eighth page, one year, each insertion, $12.00.

Front cover $150.00 per issue.

Other specified positions, regular rate plus 10 to 50 per cent.

Stippled plates used, but no heavy, black and white plates.

Advertisements in this section are inserted under regular headings.

Classified Rates

Per line, 30 cents each insertion.

No display type allowed, but the first three words may be set in capital letters.

About nine words make a line. Minimum space sold, two lines.

Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

All copy should be received at Chicago office 18 days before date of publication.

Circulation of this issue, 22,500.

Technical Publishing Co.

537 S. Dearborn Street

Chicago

Position Wanted

POSITION WANTED—As master mechanic or assistant: 21 years' experience. Had charge of erecting, repairing heavy duty engines, machinery and mixed blow turbines. Expert on lubricants. Address Practical Engineer, Box 435, Chicago, Ill. 4-1-2

WANTED—Position as engineer in pumping station or in some stationary plant. I have had 4 years' experience in engineering. What have you to offer? E. W. Adkins. Charleston, Ill. 4-1-2

POSITION WANTED—By engineer and electrician who is a technical graduate and has had 13 years' practical experience. At present employed but prefer change. Five years in present position. Reduced fuel consumption from 33 tons to 24 tons per day. Have own indicator. Can handle the Orsat. Married. Age 32. I can guarantee results. Address Perry Bartram, Box 264, Cedar Point, Ill. 4-1-2

POSITION WANTED—By man who has made steam engineering a life study; have had several years' experience; at present am student in Complete Steam Engineering course with I. C. S. Would like position as engineer, assistant or oiler, with reasonable salary to start, and where I can advance according to merits. Age 26. Address Practical Engineer, Box 419, Chicago, Ill. 4-15-1

POSITION WANTED—Chief engineer in a small plant or operator in a large; 12 years' practical experience with steam, electric, refrigerating, pumping and condensing equipment. Technical education. First-class license and references; married, age 31, employed. Practical Engineer, Box 434, Chicago, Ill. 3-15-3

POSITION WANTED—License chief engineer wants change; 12 years' experience in manufacturing and central stations, steam, electrical, refrigeration and producer gas, high speed and Corliss engines, condensers, etc. Age 32, American, and married. Address Box 437, Practical Engineer, Chicago, Ill. 4-1-2

POSITION WANTED—Chief engineer in a small plant or operator in a large; 12 years' practical experience with steam, electric, refrigerating, pumping and condensing equipment. Technical education. First-class license and references; married, age 31, employed. Practical Engineer, Box 434, Chicago, Ill. 3-15-2

POSITION WANTED—By chief engineer, 35; married. Use no liquor; 15 years' experience, electrical and refrigeration. Wants position where ability and push will count. Can get results if given opportunity. Practical Engineer, Box 436, Chicago, Ill. 3-15-3

POSITION WANTED—Inside of power plant by young man with a technical education, but no experience. For particulars write to K. Lufter, Kewaunee, Wis. 3-15-2

POSITION WANTED—Young man wants position as helper, extra engineer or fireman. Two years practical experience. I. C. S. student. Write Rasmus Stenner, 300 Fremont St., Portland, Ore. 4-15-1

POSITION WANTED—Young man wants position as helper and extra engineer in steam plant for a start. Other particulars answered by letter. Write W. D. Bellesfield, Rock Valley, Iowa. 4-15-1

POSITION WANTED—As Chief Engineer or Manager of produce cold storage plant. Am familiar with gas, oil and steam engine driven plants, also with D.C. light and power of 250 volts. Erecting, repairing and operating. Employed; married, and sober. Will go anywhere. Address Box 428, Practical Engineer, Chicago, Ill. 4-15-1

Help Wanted

WANTED—Resident subscription agents in the following cities: Atlanta, Ga.; Cincinnati and Columbus, Ohio; Kansas City, Mo.; Los Angeles, Cal.; Louisville, Ky.; Newark, N. J.; New Orleans, La.; Portland, Ore.; St. Louis, Mo.; San Francisco, Cal.; Washington, D. C. This is an excellent chance for a hustler, who is familiar with power plant conditions, to turn his spare time into dollars. To such a one we offer a Real Opportunity. Write Subscription Department, Practical Engineer, 537 S. Dearborn St., Chicago. tf.

Wanted

WANTED—Well versed boiler room and combustion men or established engineering agencies to sell mechanical stokers on a liberal commission basis. We manufacture three distinct types to meet all requirements. Natural and forced draft. Address Practical Engineer, Box 438, Chicago, Ill. 4-1-4

WANTED—Agents handling engine and boiler-room specialties in every section for side line paying large commissions. Give experience, line carried and territory covered. Address Practical Engineer, Box 381, Chicago, Ill. tf.

WANTED—Agents on commission to sell our Shaking Grates. We will install grates on trial or put it on test at our expense with any grate made. Address Armstrong Mfg. Company, Springfield, Ohio. tf.

For Sale

FOR SALE—Second-hand generating units: Two 75-kw. Ridgway direct-connected generators and engines, 230 volt. Practically new, $800 each. Engines: 18x36 Allis-Chalmers Corliss engine, latest type, heavy duty frame. Practically new. $800. Boilers: Two 250-hp. Babcock-Wilcox water-tube, 150 lb. pressure, 4 yr. service. Good as new. $2000 for both. Seven 150-hp. return tubular, butt strapped, 125 lb. pressure. Fine condition. $450 each. Power Plant Exchange, 14 Morris St., Jersey City, N. J. 4-1-2

FOR SALE—Two 1040-hp., horizontal, cross-compound, heavy duty, mill type, Buckeye engines, 24x42x36, 120 r.p.m.; each direct connected to 500-kw., 250-v., Westinghouse Type "Q" generators. Excellent condition; good as new. Now in operation. If interested, write for full information and prices. Box 197, Elyria, Ohio. 4-15-4

FOR SALE—Six volumes of Practical Engineer, six volumes of National Engineer, several copies of Power and Southern Engineer. Will sell as a whole, single volumes or numbers. Address Box 341, Sidney, Mont. 4-1-2

FOR SALE—One Burnham high-pressure hydraulic pump with governor, pressure gage, etc. Dimensions, 8½x1¼x10. Also one 12-in. Wing turbo blower. Both like new. B. F. & H. L. Sweet Co., Fond du Lac, Wis. 4-15-1

Patents and Patent Attorneys

PATENTS THAT PROTECT AND PAY—Advice and books free. High references. Best results. Promptness assured. Send sketch or model for search. WATSON E. COLEMAN, Patent Lawyer, 624 F. St., N. W., Washington, D. C. tf.

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had, and the exact costs. Send for full information. tf.

A. P. CONNOR, Consulting Electrical and Mechanical Engineer. Attorney-at-Law and Solicitor of Patents and Trade-Marks. Results guaranteed. 121 Carroll St., S. E., Washington, D. C. tf.-x.

PATENTS—Send sketch for free search and reports. Books on patents and book of reference letters sent free. John S. Duffie & Co., 612 F St., Washington, D. C. tf.

PATENTABLE IDEAS WANTED—Send for three free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf.

Miscellaneous

ENGINEERS, DO YOU WANT to utilize your exhaust steam for heating or drying purposes without back pressure on your engine? If so, address Monash Engineering Co., 1413 W. Jackson Blvd., Chicago, Ill.

FREE ENGINEER BOOKS and power plant tools and specialties, for securing new subscribers to Practical Engineer. A dandy chance for the engineer with a little spare time, to get some fine premiums. Send for free dscriptive circular and terms. Address Practical Engineer, Subscription Department, Chicago, Ill.

Sparks From The Advertising Pages

When the Whistle Blew

[This little tale founded on fact, is a narrative of events that brings out a sound moral truth, as old as human nature and never failing in its workings.—Editor's Note.]

"Say, Jack, did you see Tom, the Old Man's Son? He's tendin' the brine pump now. If I had his chance and knocked around this plant for 20 years betcha I'd have been chief or first assistant by now."

"The Old Man's Son," year in and year out, time and again was he the subject of conversation.

And the Old Man, or to give him the title that he had justly earned, the Chief Engineer, had worked and planned hard to make something of Tom. He had dreamed of him as assistant—then as his successor. He had bought books on engineering, Tom not willing to go through school. He had subscribed to power plant papers, but to no avail—Tom refused to apply himself to study and work. Indeed though his weekly wage was small it was ample for the mental and physical work he did. The chief kept him because he knew nobody else would.

Bill in the same plant was just the reverse—full of "pep" and ambition—a young man of long vision; with no more schooling than Tom, but a man who made his opportunities.

He was "a climber". And why?

Ever notice how a fellow who is "climbing" can squeeze an hour until he gets the full quota of 60 minutes—not a second lost? That was Bill's type.

At lunch time, when the whistle blew, and therein hangs the tale, Bill would proceed to a quiet niche in the engine room where he would read his power plant paper and his engineering books to the tune of a ham sandwich and a mug of coffee. Twenty minutes of this a day was fitting him for "big things."

But what of Tom? Well, when the whistle blew he would aimlessly wander off to some group of ne'er-do-wells, who worked for almost nothing and lived for the same thing, to discuss the latest murder or scandal. His long suit was the unmerciful hounding and handling of the captains of industry—the Napoleons of Finance—any and all came in for a punch in the nose from this unstrained and untrained arm of labor.

His voice could always be heard above the rest and when he had finished his ridiculous babel and foolish twaddle it was the closest approach to a perfect vacuum that one could possibly encounter. Opportunity had knocked at Tom's door and not finding it open had battered down the door and would have grabbed him by the nape of the neck and forced his submission had not Tom repulsed him with a sharp kick. After returning several times he finally gave it up as a "bad job", and it is doubtful if he ever will return again.

But with Bill, opportunity never had a chance to knock. Bill's door was always wide open and time after time Bill had shaken hands with him. Each new opportunity—each new job was a stepping stone to something better. In addition to knowing what constituted good engineering, Bill knew what constituted good engineering equipment. He could run over the gamut of legitimate manufacturers of worth-while equipment as easily as a graded student slides over the alphabet.

Naturally much of his knowledge of equipment was gleaned from the advertising pages. His partiality to advertised goods is thus explained.

Bill's a buyer now or rather has influence amounting to the same thing and he buys advertised goods because he knows they are exposed to public inspection and criticism and to the alert and analytical mind of the engineer. Bill never misses reading the advertising section of Practical Engineer.

How about you?